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CONTENTS.

EDITORIAL: PAGE.
Paragraphs ... 35

ILLUSTRATED ARTICLES:
One of Chicago's Electric Launches ... 37
Electric Conduit Road in Chicago ... 37
The Conduit on the World's Fair Grounds ... 37
Test of Two 6,500-Watt Westinghouse Transformers, by John Hopkinson ... 40
Life and Efficiency Test of Incandescent Lamps, by Prof. B. F. Thomas ... 42
A Brilliant Electric Sign ... 45
An Improved Electric Elevator ... 45
The Fulmen Arrester ... 45
The Marcus Auxiliary Mouthpiece ... 46
The Wing Fan and Diehl Motor ... 46
Pass & Seymour Single Pole Switch ... 46
The Detroit Electrical Works' Dynamo ... 46
The Billings Wire Cutter and Pipe Wrench ... 46

MISCELLANEOUS.
Use of Glucinum in Electrical Instruments, by Reginald A. Fessenden ... 36
The Alleged Superiority of the Three-Phase Motor, by John F. Kelly ... 36
Some Remarks on Dobrowolsky's Reply to the Attack on Multiphase Systems, by Chas. P. Steinmetz ... 36
Professor Thomson on the Atlantic Telephone ... 37
The City & South London Electric Railway, by Edward Hopkinson ... 38
Test of the Neversink Mountain Electric Road.—VIII., by Hermann S. Hering and Wm. S. Aldrich ... 38
Financial Aspects of Electric Lighting, by E. J. Parker ... 41
Long Distance Telephony, by Hugh Neilson ... 44
Electrical Progress in Japan ... 44
Useful Applications of Electricity ... 46

FINANCIAL INTELLIGENCE: The Electrical Stock Market, 47; New Incorporations, 47; Affairs of the Companies, 47.

SPECIAL CORRESPONDENCE: New York Notes, 48; New England Notes, 48; Western Notes, 48; Canadian Notes, 48; English Notes, 49.

NEWS OF THE WEEK: The Telephone, 49; The Electric Light, 49; The Electric Railway, 49; Miscellaneous Notes, 49.

INDUSTRIAL AND TRADE NOTES ... 49
BUSINESS NOTICES ... 49
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 50

A New Metal for Electrical Instruments. THE metal glucinum, about which comparatively little is yet known, appears from an article from one of our contributors to have some very good qualities which may give it an important place in the electrical industries, although the little that is known about it at present is hardly enough to enable one to make more than mere suggestions as to its possible future. From its atomic weight, 9.1, and its specific gravity, about 2, which appear to be the only two of its physical constants that have been measured, Mr. Fessenden determines by calculation its rigidity, tensile strength and conductivity, and finds that the former is about twice, and the tensile strength from 160 to 90 per cent. that of iron, while its conductivity is greater than that of copper, being near to silver. It is, therefore, lighter than aluminium (which is 2.7), stronger than iron, and has a better conductivity than copper, besides resisting oxidation, while its cost is estimated at about $1 per ounce. These are certainly very desirable features, and it would be very gratifying to find from actual tests that these predictions are correct. Various alloys of the well known metals have of late been experimented with largely, having in view the combination of a number of good properties in a single alloy, and in several cases very satisfactory results have been obtained; but there is still plenty of room for improvement, and with the aid of this new material, either alone or alloyed, it may be possible to greatly improve on the best of the well known alloys for use in the electrical industries. The pure metal is suggested as applicable to electrical instruments, where its extreme lightness and its high conductivity are of advantage, but there are two other qualities not mentioned in the article which are also of great importanee, namely, its temperature coefficient and its magnetic permeability: unless these are also favorable its other good qualities will lose much of their value.

Polyphase vs. Two-Phase Currents. THE discussion in our columns regarding the relative advantages of the two-phase and the polyphase alternating currents still continues, Mr. Dobrowolsky's statement having called forth some interesting replies from a number of our well-known engineers, two of which appear elsewhere in this issue. Regarding the three-phase motors, Mr. Steinmetz, in his present communication, says that the success abroad was due to the "accidental" circumstance that the frequency used there was only one-third of that usually employed in our systems. It does not seem quite fair to call this "accidental." With all due respect to American engineers, we must not forget that there are also many bright and intelligent engineers abroad, who have doubtless fully appreciated the fact that a low frequency was necessary in order to run such motors successfully; they doubtless used a low frequency *in order to* be able to run motors and transmit power over long distances, and it does not seem just to them to say that it was a mere accidental coincidence. One of the engineers of the Lauffen plant stated last year that they purposely used as low a frequency as possible. If a low frequency solves the motor and long distance problem, it would be interesting to know why the American engineers do not adopt it, at least for special plants, if it was well known here six years ago? The objections accompanying the use of low frequencies do not appear to be in proportion to the advantages gained in being able to run such motors and transmit power to great distances. If this is not the case here, why should it be so abroad? A thorough ventilation of this subject cannot fail to have a good effect and it will be of great interest to hear from others on this subject. If the advantages are greater than the objections the system ought to be introduced in this country; if they are not, the sooner it is known the better.

Conduit Roads. ALTHOUGH it will probably be difficult to find a more economical system of electric railroading than the overhead trolley, yet there are many cases in which objections are made to the poles and overhead wires necessitated by this system. In such places, as shown in the cities of New York and Chicago, cable roads are rapidly replacing horse lines, and are therefore encroaching on a field which might have been claimed by electrical traction if there had been a few conduit or storage battery roads in successful operation in this country, which overcome these objections to poles and wires. The unquestionable success of the overhead trolley roads and the lower cost of construction and operation seem to have checked the development of other systems. This is greatly to be regretted. There is a field for both. The overhead trolley will doubtless obtain the lion's share of the business, but there are plenty of street railways in large cities where the overhead wires are not allowed, and where some other system must be used. If there is no electrical system which is better than the cable, this part of the railway business will be monopolized by the latter. The recent introduction of miles of cable road in New York and Chicago has already shown this. There are two electric conduit roads at present running regularly, a long one in Budapest and a short one in Chicago, both pronouced by impartial parties to be a success. With these two as a beginning, something ought to be accomplished in the field, and it is not unlikely that the first introduction on a large scale will be made in Chicago. It is rumored that the success of the latter road was one of the reasons why the overhead trolley ordinances in Philadelphia were vetoed by the mayor. The parties who asked for overhead privileges in that city, it is said, tried to have President Yerkes pronounce the Chicago conduit system a failure, but he refused to do so, and, on the contrary, stated that it gives perfect satisfaction, on hearing which the mayor vetoed the Philadelphia ordinance. It is to be regretted that the influence of capitalists should be made use of in this way to attempt to undo that which engineers have finally accomplished after years of hard and patient work, in overcoming not only engineering difficulties but also deep-seated prejudices.

Life and Efficiency of Incandescent Lamps. AT THE recent annual meeting of the American Institute of Electrical Engineers one of the most interesting and instructive papers read was that on the life and efficiency of various incandescent lamps, the publication of which has been delayed owing to its revision by the authors. As every one knows, the efficiency of a lamp by itself means nothing unless accompanied by the life, and as the latter is a quantity not easily checked by the consumer it leaves an uncertain factor in the minds of those who have to pay for the lamps and for the power to run them, while at the same time it gives to unscrupulous companies an opportunity to overrate their goods. An impartially conducted test by reliable parties, interested only in getting at the truth, cannot fail, therefore, to be fully appreciated by electrical engineers all over the world. A test of this kind is a very tedious and tiresome one to conduct, and the authors of that paper deserve the thanks of the electrical fraternity for their valuable gratuitous contribution to the scant amount of knowledge on this subject which is accessible to the public. To review the contents here would mean to give the paper almost in full, as there is little that could be left out; it will suffice to say here that any one interested in that subject will find it to his own advantage to read and study it carefully. Among the final conclusions arrived at are the following: That of all the 127 lamps of 10 well known makes the mean horizontal candle power was only 14.5 instead of 16 as labeled, showing a mean dishonesty coefficient of about 10 per cent; that the candle power diminishes fairly uniformly at the rate of about 10 per cent. for each 200 hours; that 96 out of the 127 lamps burned longer than 1,100 hours. But the authors very correctly point out that the life of lamps ought not to be defined by the length of time that they burn, as they lose their candle power gradually and then become very uneconomical in consumption of power. They suggest that by allowing a drop from 16 to 14 candles the life as obtained from their test would be about 240 hours, which would represent a mean candle power of about 15 candles. The average initial efficiency was 4.2 watts per candle, but at 600 hours it was 5.6 and at 1,200 7 watts. Such data are very interesting and valuable, being perfectly reliable. It is a pity that the names of the individual makes could not be given, but we readily appreciate that it would not have been good policy to do so. One of the very interesting conclusions arrived at, and one which we believe was not generally known before, is that those lamps which blacken the least were claimed to have been exhausted by mechanical pumps, which seems to indicate, though it does not prove it, that the presence of mercury vapor is detrimental. This opens a wide field for the mechanical pump, and may again make the mercury pump a laboratory instrument.

Profit in Electric Lighting. A PAPER read at the recent meeting of the Canadian electricians contains some results which certainly are not encouraging to any one contemplating going into the business of running an electric lighting station with a view of earning a profit. The author of that paper obtained the results from collated information received from a number of companies. Although not encouraging, the data he gives is quite interesting and instructive. Of those using steam only five out of thirteen paid a dividend, while of those using water power eight out of nine paid dividends, even though their prices were about 10 per cent. less. This shows a very decided gain in favor of water power, notwithstanding the statements that have been made to the contrary. Out of a total capital of $1,000,000, dividends were paid on only $400,000. Other data which he quotes, taken from another source, show that only 30 out of 52 plants paid a dividend. On the face of it, this certainly looks discouraging to the growth of this industry, but on closer examination it may not prove to be as bad as it at first appears. In the first place, these plants were presumably all arc light central stations, between which there is much more competition than in the case of incandescent light stations, as the territories of the former are more likely to overlap. A proper division and limitation of territory and a mutual agreement not to cut each other's throats, would in a measure overcome this. The installations are presumably all in Canada, where, we understand, coal is expensive, rendered even more so by a government tax; this factor, therefore, does not apply to plants in our own country. Although not stated, yet it is not unlikely that the plants paying no dividends may have been the older ones which were constructed before the most profitable arrangements and methods had been found out from experience. A plant erected to-day would doubtless pay a much better dividend than one erected five years ago. Much money was undoubtedly squandered in erecting and running the earlier plants, but if the present returns from such plants do not pay dividends on this sunken capital, it is not right to discourage the erection of plants to-day which would have all the advantages of the experience of past years. Such moneys must be credited to the general instruction account for the electrical fraternity at large. It will furthermore be seen from the prices he gives for arc lights in different cities that those in Canada are considerably less than those paid in this country; his remarks need not therefore discourage this industry in the United States. There is still another feature which should not be overlooked, namely, the increasing use of current for electric motors during the day time, from which a revenue can be obtained for machinery which otherwise earns nothing during the greater part of the day. The running of motors is, however, not as easy in connection with series arc light plants as it is in multiple arc systems, but with the rapid progress which is being made in electric lighting it is not unlikely that series systems of distribution of power for independent motors will become much more satisfactory than they are to-day. A paper such as the one commented on, it seems to us, should be used as a guide to teach engineers how to erect paying plants, and not as a means to discourage capital in such a useful industry as electric arc lighting.

Use of Glucinum in Electrical Instruments.

BY REGINALD A. FESSENDEN.

If we had a metal which was lighter and less easily oxidized than aluminium, more rigid and of greater tensile strength than iron, a better conductor than and as malleable as silver, there is very little doubt but that it would be largely used in the better class of electrical instruments, even if it were as expensive as platinum.

It may, therefore, be worth while to point out that in all probability we have such a metal, and that it can be produced for a small fraction of the cost of platinum.

The metal referred to is glucinum. It is true that its physical constants have never been determined, but they may easily be predicted from the two known facts, 1st, that its atomic weight is 9.1; 2d, that its specific gravity lies somewhere about the values 2·1 (given by Debray) and 1.7 (Nilson). The probable value may be taken as 2, as Debray's metal was more pure than Nilson's.

From these facts and the knowledge that glucinum is malleable, and is related to the magnesium group, we get the following constants: Specific gravity of aluminium, 2.7; specific gravity of glucinum, 2; rigidity of glucinum, 1,350 × 10 degrees; rigidity of iron, 750 × 10 degrees; tensile strength of glucinum, 65 kgms. for a wire 1 mm. in diameter; tensile strength of iron, 40-70 kgms. for a wire 1 mm. in diameter; conductivity of glucinum, 105; conductivity of silver, 100.

If the lower specific gravity of glucinum, 1.7, be taken, and its melting point be taken as less than that of silver, its conductivity will then only be 95 as compared with silver, but it will still be a better conductor than copper.

As to the cost of the metal, ore containing 5 per cent. of metallic glucinum can be had at present for 25 cents a pound. This would give $5.00 as the cost of ore containing one pound of the metal. The best process for making it would probably be a modification of Castner's sodium process for aluminium. The actual cost of working this was less than 50 cents per pound of aluminium and the percentage of metal obtained to that in the ore at least 80 per cent. Suppose in the case of glucinum the cost of working was four times as much, or $2 per pound, and the percentage of metal obtained only 50 per cent., the cost of one pound of the metal would be $10, call it $16 per pound. or $1 per ounce. As its specific gravity is only 2, bulk for bulk it would only cost one-eightieth of the amount that platinum does and one-fifth of the amount that silver does.

For these reasons then, its great lightness, its resistance to oxidation, its great rigidity, tensile strength and malleability, its excellent conductivity and comparatively moderate cost of production, we may expect to see this metal used in instrument work in the future.

The Alleged Superiority of the Three Phase Motor.

BY JOHN F. KELLY.

Some time since in these columns I called attention to what I regarded as an erroneous treatment of the theory of multiphase motors by Herr von Dolivo-Dobrowolsky. I did not at the time call into question the superiority of the three-phase motor as designed by Herr von Dolivo-Dobrowolsky to the two-phase Tesla motor. I merely attempted to show, I think successfully, that the reasons advanced by Herr von Dolivo-Dobrowolsky for the superiority are not simply insufficient, but non-existent; and that, consequently, if such superiority really exist some other explanation must be found for it.

In your issue of July 2, page 4, Herr von Dolivo-Dobrowolsky replies to the "attack" on the three-phase motor. To do so he does not at all find it necessary to deal with my arguments; he seems, in fact, inspired with a sudden disgust for mathematics. His reply in the main consists of a charge of "misoneism" directed against me in common with the majority of English and American engineers. The charge, as regards me, is as truthful as one of misanthropy, and has about as much bearing on the question at issue. I am, indeed, conservative enough to believe that twice two is four, and the novelty of calling it five has no attractions for me. This is the kind of "misoneism" I display toward Herr von Dolivo-Dobrowolsky's theories.

Had Herr von Dolivo-Dobrowolsky confined himself to this charge, I would not have taken the trouble of writing on the matter again. But while professedly disclaiming an appeal to mathematics, he makes a mathematical argument in regard to the constancy of the power supplied by the circuits, which, in a somewhat different way, involves the fallacy I have already exposed in regard to the constancy of the magnetizing force and the rotating pole. The power supplied by any one of the circuits, he says, may be represented by a sinusoidal curve, and the addition of two sinusoids cannot produce a straight line. Now it is only by a loose use of language that the power curves can be called sinusoidal, and it will not do to base an argument on such use. When the electromotive forces and currents are sinusoidal, the power curves are curves of squares of sines, and two such curves of equal amplitude differing 90° in phase will add so as to produce an exactly straight line.

If, in fact, we represent by E the maximum value of the E. M. F. in either circuit, and by A the maximum value o the current, we have for the instantaneous values of the respective E. M. Fs. and currents

$$E \sin 2\pi \frac{t}{T}; \quad A \sin 2\pi \left(\frac{t}{T} - \varphi\right) \qquad (1)$$

$$E \cos 2\pi \frac{t}{T}; \quad A \cos 2\pi \left(\frac{t}{T} - \varphi\right) \qquad (2)$$

$2\pi\varphi$ being the angle of lag.

The instantaneous values of the rate of doing work in each circuit will be, therefore,

$$E A \sin 2\pi \frac{t}{T} \sin 2\pi \left(\frac{t}{T} - \varphi\right) \qquad (1)$$

$$E A \cos 2\pi \frac{t}{T} \cos 2\pi \left(\frac{t}{T} - \varphi\right) \qquad (2)$$

and these expressions developed give, respectively,

$$E A \left(\sin^2 2\pi \frac{t}{T} \cos 2\pi\varphi - \sin 2\pi \frac{t}{T} \cos 2\pi \frac{t}{T} \sin 2\pi\varphi\right) \qquad (1)$$

$$E A \left(\cos^2 2\pi \frac{t}{T} \cos 2\pi\varphi + \sin 2\pi \frac{t}{T} \cos 2\pi \frac{t}{T} \sin 2\pi\varphi\right) \qquad (2)$$

Adding these together we have for the joint rate of working

$$E A \cos 2\pi\varphi \left(\sin^2 2\pi \frac{t}{T} + \cos^2 2\pi \frac{t}{T}\right);$$

an expression which, since the sum of the squares of the sine and cosine of any angle is equal to unity, is independent of the value of (t), and hence constant.

Herr von Dolivo-Dobrowolsky seems to intimate that if I am dissatisfied with his explanation of the superiority of the three-phase motor I am called upon to supply a better. But this would not be the case even were I convinced of this superiority. The figures given by Herr von Dolivo-Dobrowolsky, while they show a high degree of merit in the three-phase motor, are not sufficient to prove it better than the two. Unless I am misinformed, the Westinghouse engineers claim equally good results for the two-phase motor as built by them.

I consider that I have sufficiently demonstrated that two sinusoidal currents can convey a constant amount of energy, and that two such currents can combine to produce as constant a rotary magnetomotive force as three. Unless some one points out some error in my reasoning, or that three-phase currents are capable of doing more than this, I shall consider the case closed.

STANLEY LABORATORY, July 2, 1892.

Some Remarks on Dobrowolsky's Reply to the Attack on Multiphase Current Systems.

BY CHAS. PROTEUS STEINMETZ.

Having already expressed my views on the polyphase current system several times, I consider myself entitled to make some remarks on Mr. Dobrowolsky's reply. I do not wish to decry the polyphase current system; on the contrary, I believe that a great deal of the opposition to it is due only to the fact that people decry that which they do not understand and cannot grasp. The same thing was noticed a few years ago when the alternate current transformer system for electric lighting was introduced.

It is to be regretted very much that Mr. Dobrowolsky in his reply "did not care to go into mathematics," as he would have found that, if two sinusoidal currents lag behind each other by one-quarter of a period, their watt curves lag behind each other, not by one-quarter, as he says, but by one-half a period, since the watt curve makes a full period for each half period of the current curve. Hence the sum of the watt curves of two sinusoidal alternating currents of one-quarter period difference of phase does not vary about 40 per cent., as Mr. Dobrowolsky claims, but is constant, that is, the curve is a straight line, and, therefore, all the conclusions which Mr. Dobrowolsky draws from this are not sound.

It is a fundamental law, that in any symmetrical system of polyphase currents, no matter whether two, three or any other number of phases are used, the sum of the instantaneous values of the watts is a constant.

For, let the E. M. F. of an n-phase system be represented by

$$e = E \sin\left(\varphi + \kappa \frac{2\pi}{n}\right)$$

where $\kappa = 0, 1, 2 \ldots (n-1)$, then the current is

$$c = C \sin\left(\varphi + \alpha + \kappa \frac{2\pi}{n}\right)$$

in which α is the angle of retardation.

Hence the value of the power is:

$$e\,c = E\,C \sin\left(\varphi + \kappa \frac{2\pi}{n}\right) \sin\left(\varphi + \alpha + \kappa \frac{2\pi}{n}\right)$$

$$= \frac{E\,C}{2} \cos\alpha - \frac{E\,C}{2} \cos\left(2\varphi + \alpha + 2\kappa \frac{2\pi}{n}\right)$$

and consequently the sum of the instantaneous power values of all the n currents is:

$$\sum_{o}^{n-1}{}_{\kappa} e\,c = \frac{n\,E\,C \cos\alpha}{2} - \frac{E\,C}{2} \sum_{o}^{n-1}{}_{\kappa} \cos\left(2\varphi + \alpha + 2\kappa \frac{2\pi}{n}\right)$$

but since the last term is equal to zero this is equal to

$$\frac{n\,E\,C \cos\alpha}{2}$$

This is the reason why the polyphase system can be so easily transformed from one number of phases to any other number. It is therefore just as easy to convert two currents having one-quarter period difference of phase into three or six currents, by appropriate electromagnetic transformers, as it is to transform three-phase currents into six currents, or into two currents with a quarter period lag, since no storage of energy is required; or they may even be converted into continuous currents by rotary converters, while the conversion from and into alternating currents (that is, currents with a fluctuating watt curve) requires motor generators or other apparatus capable of storing up the surplus energy during the time of the maximum, and returning it during the time of the minimum of the watt curve. Since energy cannot be stored economically by means of electromagnetism, on account of the high iron losses in the hysteresis, the attempts to split up a simple alternating current by means of transformers into currents having a difference of phase have proved to be unsuccessful from an economical standpoint.

In this respect the polyphase system is a great step in advance, in so far that it combines the advantages of the alternate current (electromagnetic transformation) with those of the continuous currents (straight line watt curve). But this applies to the quarter phase system of Tesla and Ferraris, just as well as to the three-phase system.

The rotation of a magnetic field of a uniform strength and at a uniform speed can be effected by two sine waves at one-quarter of a period difference in phase, just as well as with three phase currents, as may be easily seen by properly combining the M. M. Fs. of the currents, not, however, by simply adding together forces acting in different directions, but by combining them according to the law of the parallelogram of forces, which is true for all vector quantities, and therefore also for M. M. Fs. Two currents, whose sum is a constant, cannot generate a uniformly rotating magnetic field. The only advantage gained by increasing the number of phases lies, therefore, in the fact that the greater the number of phases the less will any deviations of the current curves from a true sine curve introduce objectionable effects.

Regarding the starting torque of the polyphase motor it would be beyond the scope of the present remarks to go into a detailed explanation. I will therefore confine myself to saying that the converter motor (that is, the motor in which the armature current is induced in it by a converter action) acts exactly like a continuous current shunt motor and is, electrically, really a shunt motor. When running idle it consumes only as much current as is necessary to generate the magnetism, and by proper designing this "leakage current" can be made very small, though not quite as small perhaps as the leakage current of the closed circuit transformer, because of the air reluctance which is unavoidable in the motor. With an increasing load the current will increase by the amount necessary to generate the power required. When the full voltage is applied to a motor at rest it will also behave like the continuous current shunt motor, that is, it will either start or burn out; by the introduction of a resistance into the armature circuit when starting it is made self-starting even when loaded, just as the shunt motor. Small motors, with considerable armature resistance and correspondingly low efficiency, may be started even without an additional resistance.

Such shunt motors differ essentially from series motors, in that with the former the torque at starting is less than proportional to the current on account of the drop in the magnetization, while with the latter the torque at starting is far greater than proportional to the current. For this reason shunt and converter motors can never have the powerful starting torque that series motors have.

The polyphase system of transmission and distribution is undoubtedly, within certain limits, a decided step in advance over the simple alternating current; but as the calculations regarding the 40 per cent. fluctuations in the quarter phase and the 14 per cent. fluctuations in the three phase system are erroneous, because they are based on wrong premises,* I really cannot see any new idea nor any progress whatsoever, in the introduction of the three phase system in place of the old quarter phase system. It was evidently only its connection with the celebrated Frankfort-Lauffen high-pressure power transmission which brought a system into the foreground which was a failure here; it was successful there only on account of the accidental circumstance that the frequency used on the continent is somewhat less than one-third that which is customary here, and that consequently a motor will work there which will not run here on our alternating current lines, where it encounters over three times the counter E. M. F. of self-induction.

That the polyphase system does not meet with very great enthusiasm here is not due to any hatred, prejudice or malignity, but simply to the fact that this system has been known to us here for the past six years, and we have got all the experience with it we care to have for the present.

In conclusion I can only express my agreement with Mr. Dobrowolsky's closing remark, that people should be requested not to rush into print so hastily, but should first make inquiries whether theories and explanations are correct, and are not based on erroneous assumptions.

* See my remarks in the Transactions of the American Institute of Electrical Engineers, December, 1891, and February, 1892.

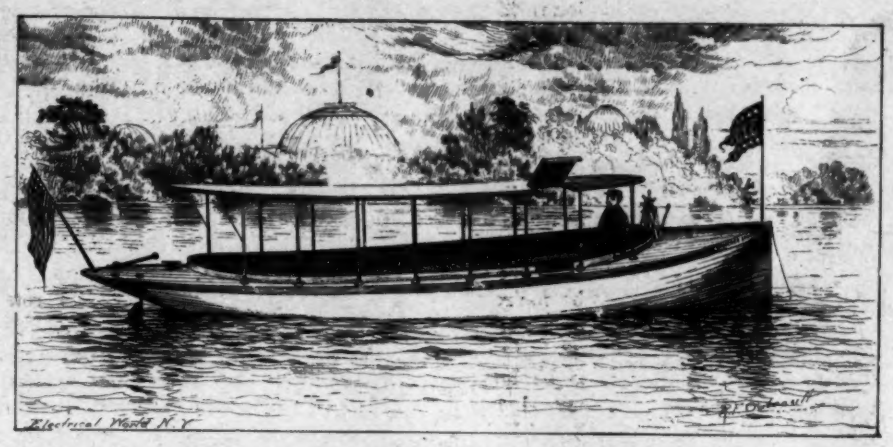
One of Chicago's Electric Launches.

In the illustration on this page is shown one of the Chicago Launch Club's boats which was built especially for an electric launch, and which is now fitted with an electric motor and a storage battery equipment. The boat is 36 feet long over all, 7½ foot beam and 36 inches in depth. When fully equipped with the necessary motor and batteries the boat draws 28 inches of water. Below the decks there is sufficient room for 104 cells of battery which fit snugly into the places made for them. These cells are manufactured by the American Battery Company, and give an electromotive force of about two volts. The cells are encased in hard rubber and covered with a lid of the same material, which is sealed down. The motor is of the Jenney type and is rated at five h. p. It is coupled direct with the screw by a specially devised clamp. From the motor shaft a small sewing machine belt drives a diminutive pump, which serves to keep the space below the battery deck very dry.

As will be seen from the illustration, the wheel and the reversing lever are in the bow, where there is also placed a three-point switch for controlling the speed. By means of the different battery connections three different speeds can be attained. The boat has made a record of 12 miles an hour, but of course no such speed is required on the lagoons in the World's Fair grounds, where the boat is to ply back and forth, as passengers will much prefer to travel at the rate of three or four miles an hour, so that they may inspect the different parts of the grounds along the banks of the lagoons.

The illustration shows the place arranged for receiving and discharging passengers. The circuit in going around the grounds is always to the left and the boats always stop at the wharves on the starboard side. At a large wharf under one of the bridges are charging boxes and it is intended that the boats shall put in there during the night and be recharged for the next day's work. It is said that six hours is required to charge the cells.

The boat is handsomely carpeted and cushioned and the decks forward and aft are finished in mahogany. The motor is placed directly on the bottom of the boat in the stern.



CHICAGO LAUNCH CLUB'S ELECTRIC BOAT.

Electric Conduit Road in Chicago.

While the hot battle for and against the overhead trolley has been going on between the street car companies and the municipal authorities in various cities, resulting in New York and Chicago in the adoption of the cable, a street car company in the latter city has been experimenting quietly with a conduit electric road in order to satisfy itself on the question of the possibility of working such a road successfully. This road has now been running a number of months and from all reports appears to have given complete satisfaction; a short description of it may therefore be of interest.

The conduit used is that known as the Love system, already mentioned and illustrated in our issue of July 4, 1891. It has since been changed slightly in details and improved in accordance with requirements which its introduction into practice have shown to be necessary. Much of its present success is due to the earnest efforts of the general manager, Mr. Albert G. Wheeler.

The accompanying illustration explains itself and needs little comment. One of the important features is that the top cover of the conduit consists of rolled steel strips or angle irons, having a deep vertical flange on the side bounding the slot. These angle-irons are laid in long lengths, being secured in place by the clamps shown; by releasing these fastenings, which is a very simple matter, the angle irons are readily removed, which opens the conduit and renders it easily accessible for examining and repairing the wires, cleaning the conduits, and other purposes. This appears to be a very important feature, as one of the difficulties with a conduit is usually its inaccessibility, unless made large enough to admit a man, in which case it becomes expensive. It is stated that it requires but a few men and a very short time to open long lengths of this conduit.

The flange on the slot side extends lower down than the wires, and therefore protects them in a measure from interference on the part of the meddlesome small boy, who in other systems delighted in poking wires into the slot and seeing the sparks fly. It will be noticed, too, that both lead and return are insulated, which overcomes a number of difficulties experienced on grounded railroad circuits, and too well known to be enumerated here. The overcoming of these difficulties is by no means a matter of small importance.

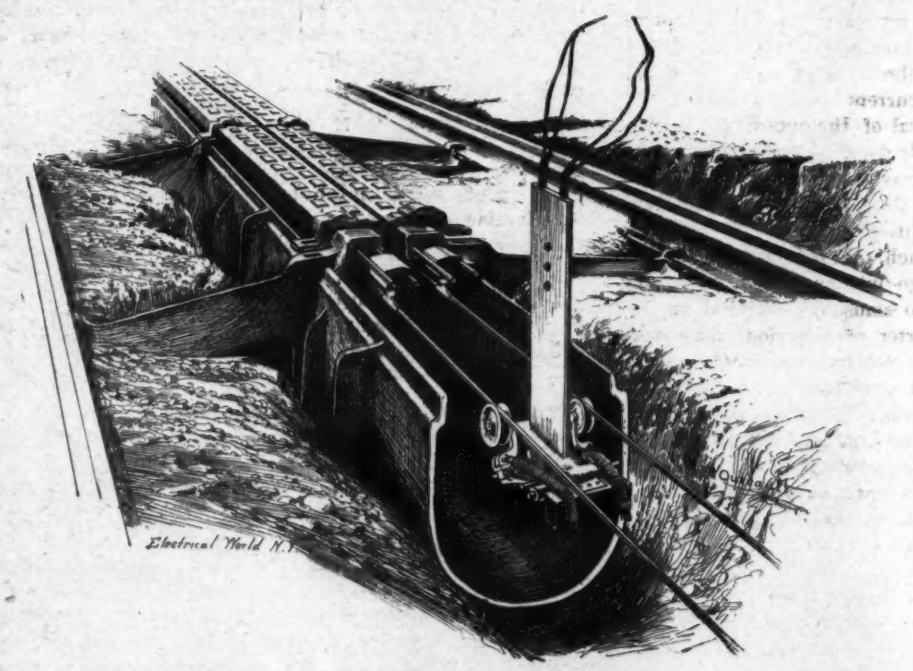
Another feature is the means of support and insulation of the trolley wires, as shown in the cut. Great difficulties were at first experienced in the insulated support, but they claim that the present form overcomes all this and that it is perfectly satisfactory, the wires being well insulated even in very wet weather, and when the streets are flooded with water. As will be seen, this arrangement takes care of the expansion and contraction of the wires. The rest of the conduit construction, with the rail supports, roadbed and rails, are said to be the same as those of the best cable roads

One of the parts which was very troublesome at first is the trolley itself, but now they state that they have overcome this also and that the very simple form of trolley shown, which is the one used now, is perfectly satisfactory. The trolley wheels are slightly smaller than those used on overhead roads and are loosely supported so as to admit of a small amount of play in all directions, just enough to adapt themselves to the inevitable slight irregularities, chiefly at curves. The whole trolley bar is easily detached and replaced if broken.

The conduit is well drained by means of frequent pipe connections to the sewers and settling boxes. In order to clean it of mud and other sediment, a brush is attached to the trolley, which sweeps the dirt into receiving boxes.

The road is one and five-eighth miles long, embracing four curves of 35, 45 and 55 degrees radius, two double and two single track crossings and 10 switches. It was built during the past winter on the tracks of the North Chicago Street Railway Company.

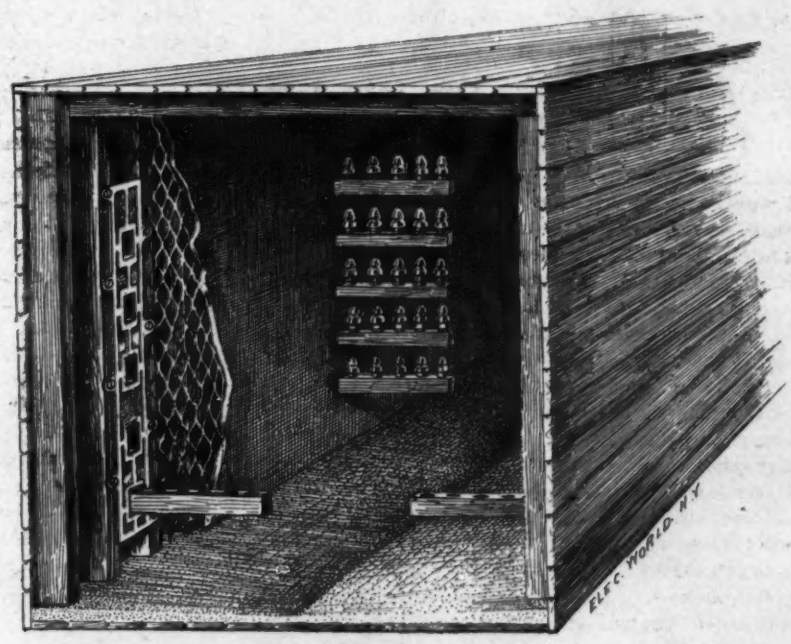
That the road has been running quite successfully is best shown by the fact that the North Chicago Street Railway Company has accepted the road. In a letter from President Yerkes, of that company, he says, "So far as the system itself is concerned it gives us perfect satisfaction, and contrary to my fears the insulation is not interfered with in any manner by moisture. We have had some of the most severe rains in this vicinity during the past three or four months that I have ever experienced, so much so that at one time the cars ran through water on the track three or four inches deep, the trolley in the conduit running in the water, owing to the inability of the sewer connections to carry off the flood fast enough, but at no time was the road stopped from this cause." After referring to some unfavorable points in the construction, he says, "with proper construction I believe the Love system would be a great success. . . . We have demonstrated that we could operate five times the number of cars that we are now doing with practically the same expense. . . . Your claim that your system is free from danger to the public is fully sustained."



THE LOVE ELECTRIC CONDUIT.

The Conduit on the World's Fair Grounds.

To provide for carrying the immense number of wires from the central power station in the Machinery Hall on the World's Fair grounds to the electrical and other buildings where current is to be used, an immense conduit 6½ feet square has been built directly under the Machinery Hall. This conduit extends across the grounds only very slightly below the surface to the Electrical Building, from which branches are carried to other sections of the grounds. The accompanying illustration gives a good idea of the construction of this conduit. It has a timbered framework, and is completely inclosed by thick planking spiked to the frame work on the outside. The studding, a part of which is shown at the left of the illustration, is composed of 3 × 6 inch timbers set about 9 or 10 inches apart. The arms for carrying the wires are attached to the cribwork by means of cast iron socket frames, which are attached by heavy lag screws to the studding, as shown in the illustration. These iron frames are made with a number of deep sockets into which arms are driven and which afford a broad and ample bearing surface for their support. The arms are driven back against the planking on the outside of the cribwork. Over the inside of the studding is placed a covering of latticework, shown in the illustration, to which is attached an artificial plaster board, so that the framework of the conduit is entirely sealed. On the cross arms are carried ordinary insulators to which the cables are attached in the usual way. Arms are carried on both sides of the conduit and are just long enough to leave space in the centre for a man to walk through conveniently whenever it is necessary to inspect the wires or to make any repairs. The floor of the conduit is slightly V-shaped to carry off any water which may get into the conduit. The illustration shows the entrance to the conduit directly under the power house. The whole construction is substantial, inexpensive and permits of ready access to the wires which are carried through the subway.



ELECTRIC SUBWAY ON THE WORLD'S FAIR GROUNDS.

Professor Thomson on the Atlantic Telephone.

"The telephone, even when first brought out, was a marvel of simplicity and effectiveness," says Professor Elihu Thomson in an article on "The Future of Electricity" in the July *New England Magazine*. "When we consider that by its means we may converse with and even recognize the voice of a person distant from us a considerable fraction of the earth's circumference, we cannot fail to be impressed with the wonder of it. Can we, however, anticipate such an extension of the power of the telephone that we may at some time use an ocean cable as the line over which speech is to be conveyed? To answer this question in the negative would be to set a limit to the capacity of the human intellect to make future advances; nevertheless, there are reasons which are cogent enough tending to point to the impracticability of telephonic transmission through cables of great length. In such cases a retardation and an obliteration of the delicate pulses of current which characterize electrical speech serve to prevent the reception of speech at the far end of the line."

The City & South London Electric Railway.

BY EDWARD HOPKINSON.

In the present session of Parliament no fewer than six bills have been introduced authorizing the construction of new underground railways in London to be worked electrically, or the extension of those for which acts of Parliament have already been obtained. Three of these bills have passed through the House of Commons and are in an advanced stage in the Upper House. The present time, therefore, is opportune for drawing attention to the results which have been attained with electric traction on the only railway in the world on which it has been adopted on an extensive scale, and the working of which during the 18 months it has been open for public traffic is the basis upon which the promoters of the present schemes found their application for parliamentary powers, and from which they must in the future seek the confidence of the public. That the City & South London line has been a success in the system of traction adopted is conclusively shown by the mere fact of the present schemes being brought forward, and has moreover been abundantly proved by the evidence given before the joint committee of both Houses, appointed to consider the proposed lines from the point of view of their public utility, and also by the evidence given as the bills passed through committee in the Lower House; but no authentic information has been forthcoming as to the actual results achieved nor any explanation of any shortcomings in its working, which must be obviated in the future.

The limits of a letter do not permit the discussion of the engineering features of the electrical plant adopted, but as my firm designed and constructed the whole of the electrical equipment of the railway, the present occasion is not inopportune either in time or place for me to give a brief account of the history of the first year's working and of the results achieved, leaving for some other occasion a discussion of the technical details.

The City & South London Railway Company, then known as the City of London & Southwark Subway Company, obtained its first parliamentary powers in 1884 for the construction of a subway from King William street in the city to the Elephant and Castle in Southwark. The success, however, of Mr. Greathead's beautiful system of constructing the tunnels, now familiar to all interested in engineering matters, had been so conspicuous that the directors obtained powers in 1887 for an extension to the Swan Inn at Stockwell. Further powers have since been obtained for an extension southward to Clapham, but this portion of the line has not yet been constructed. It was originally intended that the subway should be worked on the cable system and contracts were actually entered into for this purpose, but the progress of electrical traction in the interval made it necessary to reconsider the system of traction to be adopted. The Bessbrook and Newry Tramway (more correctly described as a railway) had been equipped with electrical plant by Messrs. Mather & Platt and had been running with perfect regularity for three years. The weight of the trains on this line were but little less than the weight of the trains proposed for the South London line, but the cost of haulage had been proved not to exceed 4d. per train mile, although the mileage was small and consequently fixed expenses high in proportion. The success attending the Bessbrook line induced Messrs. Mather & Platt in 1883 to approach the directors of the City & South London line and to make definite proposals to them for working their line electrically instead of by cable. After long consideration the cable system was finally abandoned and Messrs. Mather & Platt's scheme accepted in its entirety. Their proposals was accompanied by an offer to work the line for a limited period or to guarantee the cost of traction for two years. The locomotives were to be designed for drawing trains consisting of three carriages accommodating 100 passengers, and weighing 4½ tons each, and the generating plant was to be sufficient for working a service of 20 trains per hour. A contract was entered into with Messrs. Mather & Platt in January, 1889, and their guarantee accepted that the cost of haulage exclusive of driver's wages should not exceed 3¼ pence per train mile for the maximum service proposed, viz.: 384,800 train miles in the half year, and according to a sliding scale, if the mileage were more or less, increasing up to 7½ pence per train mile for 188,666 miles, the actual mileage accomplished. The works were completed in November, 1890, and on the 4th of November were formally inaugurated by the Prince of Wales, accompanied by the late Duke of Clarence. On December 18, 1890, the line was opened for public traffic, and has now completed eighteen months running. During this time Messrs. Mather & Platt's locomotives have run more than 500,000 miles and have provided for a traffic of more than 7,000,000 people; but this statement alone does not fully represent the work which has been demanded from them. Owing to the carriages being stronger and heavier than originally designed, the actual load of each carriage being seven tons instead of four and one-half tons, the weight of the loaded train was increased to 42 tons, or more than 40 per cent. heavier than the trains for which the locomotives were designed. Of this great increase in the loads which their locomotives were to draw, Messrs. Mather & Platt had no intimation until after all the locomotives were constructed and delivered, and arrangements had been made for the opening of the line. Under such unexpected circumstances the locomotives have at times been overstrained and delays to the traffic resulted, and the wear and tear have proved somewhat greater than originally anticipated, yet the record of work done by the electrical locomotives in comparison with the work done by steam locomotives is extraordinary. Leaving out of consideration one of the locomotives of special type made for the purpose of testing its comparative efficiency, the average mileage made by the remaining 13 locomotives during the first year of work exceeded 27,000 miles. On the Metropolitan district railway the yearly average of their locomotives appears to be less than 20,000 miles. The cost of working has proved equally satisfactory. Although the formal guarantee of Messrs. Mather & Platt was not taken up, on account of the carriages failing to comply with the specification upon which they were requested to base their calculations, yet their estimate of cost has been amply justified. During the second six months of working, according to the published half yearly accounts, the cost of locomotives and generating power, including wages, repairs and renewals, was £6,199 for a mileage of 188,666, or less than 8d. per mile. If allowance be made for the drivers' wages, which were excluded from the original estimate, this is equivalent to about 5¼d. per train mile, 25 per cent. less than the amount guaranteed by Messrs. Mather & Platt, although the weight of the trains had been increased 40 per cent. These facts are the more striking when the difficulties of adequate and regular inspection of the rolling stock of a line entirely underground are considered; difficulties which do not obtain in the case of any ordinary railway, and when it is further remembered that the entire system of working was novel, to which the employés were unaccustomed and for which they had received no special training.

Under the management of Mr. Basil Mott, the company's engineer, and Mr. T. C. Jenkin, the general manager, it is probable that the working expenses will be further reduced, while the mileage and traffic receipts are increased.

The distinguishing feature of Messrs. Mather & Platt's locomotives is that the armature is constructed directly upon the axle, and the magnets supported partly upon the axle and partly upon the frame. Probably this design, obviating all gear and reducing the mechanics to the simplest elements, has contributed more than anything else to the successful working. For the heavier trains which will be required for the working of the new lines there will be no difficulty in designing heavier and more powerful locomotives on the same principle. In the schemes now under consideration Mr. Greathead is proposing larger tunnels 12 feet in diameter instead of 10 feet, as in the case of the City & South London line. This will greatly facilitate the construction of larger locomotives and more commodious and comfortable carriages, which are the chief points necessary to insure the success of the new undertakings.

Test of the Neversink Mountain Electric Road.—VIII.*

BY HERMANN S. HERING AND WILLIAM S. ALDRICH, OF JOHNS HOPKINS UNIVERSITY.

VII.—SPECIAL CAR TEST (*Continued*).

Remarks on the Speed Diagrams.—The car-route profile given in Fig. 22 of the preceding issue has been plotted from the data of the road survey, already referred to, on standard profile paper, the scale of miles having its zero at Klapperthal terminal and all the road distances being horizontal measurements. The Boyer diagram of Fig. 23 was made on the ruled paper used by the instrument, the scale zero being taken at one of the ruled ordinates, which is, of course, not at any particular point of the road. This difference in the relative locations of the scale zeros needs to be carefully borne in mind in using either of the scales to compare distances along the road.

The Boyer record is from a blue print of a tracing, and on account of the unequal shrinkage, the distances cannot be accurately measured up. The slip of the car wheels on the various grades and curves precludes the distances as measured on the Boyer record from being exact track lengths. For these reasons the turnouts, switches and stations, located on the Boyer ruled paper, are not always coincident with those on the profile, and distances between points on the road will also be found to be slightly different; but they agree sufficiently close to show in general the speed variations at the different points along the road, which is the reason for placing them together. The Boyer record shows clearly the variations in speed caused by the turnouts and the curvature of the road; for instance, on the stretch of road between turnouts No. 4 and No. 7, on the north side of the mountain, which contains but few curves, the car speed was nearly constant; while on that on the south side of the mountain, a portion composed almost entirely of curves, many of them very sharp, the speed varied greatly. The speed of the car passing over turnouts and around sharp curves is shown clearly on the Boyer record while the car was passing turnouts No. 5 and No. 6, on the north side of the mountain, and also the several curves marked on the car-route diagram.

A careful study of Mr. Hewitt's speed curve in connection with the car-route profile and plot of the curvature, will reveal many interesting points.

Table XII. contains the mean speeds for the usual car route as compiled from the three special car tests; namely, car No. 2, June 24, 1891, made by Mr. Chas. Hewitt for the Edison General Electric Company, a short time after the completion of the road; car No. 4, Aug. 17-18, 1891, being the special car test made for this article by the authors.

TABLE XII.

MEAN SPEEDS ON GRADES AND FOR CAR-ROUTE, EXCLUDING STOPS.

Neversink. Car used in test.	Up grade. Car lift, in ft. per min.	Up grade. Car speed, in ft. per min.	Up grade. Car speed, in miles per hour.	Down grade. Car drop, in ft. per min.	Down grade. Car speed in ft. per min.	Down grade. Car speed, in miles per hour.	Car-route (total). Car speed, in ft. per min.	Car-route (total). Car speed in miles per hour.	Date of test.
No. 2.....	32.8	872	9.9	40.4	1,160	13.2	1,004	11.4	June 24, 1891.
No. 4.....	34.0	906	10.3	36.0	1,044	11.87	973	11.05	Aug. 17 18, 1891.
No. 3.....	32.0	855	9.7	34.5	997	11.3	924	10.5	April 30, 1892.

TABLE NO. XIII.

HEWITT'S TEST OF CAR NO. 2 WITH DIFFERENT POSITIONS OF THE REGULATING SWITCH, MADE JUNE 24, 1891.

Position of switch.	Volts. Highest.	Volts. Lowest.	Volts. Mean.	Ampères "A." Highest.	Ampères "A." Lowest.	Ampères "A." Mean.	Ampères "B." Highest.	Ampères "B." Lowest.	Ampères "B." Mean.	Difference in ampères. Highest.	Difference in ampères. Lowest.	Difference in ampères. Mean.	Total average ampères.	Average electrical horse power delivered to motors.	Distance in feet.	Speeds. Speed, feet per min.	Speeds. Average speed miles per hour.	Speeds. Car lift, feet, per min.	Calculated mechanical horse power at car axle. Lift horse power.	Calculated mechanical horse power at car axle. Traction horse power.	Calculated mechanical horse power at car axle. Total car axle horse power.	Calculated efficiency from motor terminals to car axle.	Notes.
1st.	440	390	409	42	22	26.4	50	25	30.2	13	1	3.8	56.6	31	363	502	5.7	20.3	13.8	3.46	17 26	55.7	Test made on straight track. Grade, 4 per cent. Car carrying 5 passengers. Weight of car and load 22,700 lbs. Traction coef. taken at 10 lbs. per 1,000 Date of test, June 24, 1891. "A," forward motor. "B," rear motor.
4th,	400	340	360	42	20	26	45	26	31	7	3	5	57	27.5	429	551	6.26	22	15.15	3.8	18.95	69.1	
5th.	475	250	328	42	30	38	45	25	30	15	0	8	68	30	396	726	8.24	28	19.13	5 0	24.3	81.2	
First test. 5th.	450	395	414	50	34	44	50	24	31	21	0	13	75	42.4	429	863	9.8	34.5	23.8	5.95	29.75	70.3	
Second test. 7th.	500	350	389	50	30	35.4	50	32	37.7	5	0	2.3	73.1	38.1	462	863	9.8	34.5	23.8	5.95	29.75	78.2	

TABLE NO. XIV.

TEST OF CAR NO. 3, WITH DIFFERENT POSITIONS OF THE REGULATING SWITCH, MADE APRIL 30, 1892.

Position of switch.	Volts. Highest.	Volts. Lowest.	Volts. Integrated mean.	Ampères. Highest.	Ampères. Lowest.	Ampères. Integrated mean.	Integrated electrical horse-power delivered to motors	Time interval, seconds.	Speeds. Av'rage speed, feet per min.	Speeds. Av'rage speed, miles per hour.	Speeds. Car lift, feet per min.	Calculated mechanical horse power at car axle. Lift horse power.	Calculated mechanical horse power at car axle. Traction horse power.	Calculated mechanical horse power at car axle. Total car axle horse power.	Calculated efficiency from motor terminals to car axle.	Notes.
2d....	488	445	473	62.6	54.8	57 8	36.8	75	660	7.5	23.1	16.6	5.0	21.6	58.8	Test made on straight track. Length of track 825 feet. Grade, 3½ per cent. Car lift, 28.8 feet. Car carrying 14 passengers. Weight of car and load 23,800 lbs. Traction coef. taken as 10 lbs. per 1,000. Date of test April 30, 1892.
4th ..	493	440	476	58.6	51.8	56.0	35.3	66	750	8.56	26.2	18.9	5.6	24.5	69.5	
6th ..	531	472	502	71.5	58.6	65.4	44.0	48	1,035	11.7	37.0	26.0	7.8	33.8	77.0	
7th ..	515	466	488	78.5	61.7	67.5	45.0	46	1,075	12.2	37.6	27.1	8.2	35.3	78.5	

* For the first seven sections of this article see THE ELECTRICAL WORLD of May 28, June 4, 11, 18, 25, July 2 and 9, 1892.

and car No. 3, April 30, 1892, made by the authors with the students of the Electrical Engineering course of the John Hopkins University, while in Reading during a recent tour of inspection, a short account of which tour was given in THE ELECTRICAL WORLD, page 351, May 21, 1892.

Cars Nos. 2 and 4 were run from car house to car house, while No. 3 was run from Klapperthal to Klapperthal, and the mean values on all the up-grades as well as on all the down-grades have been taken for these respective routes. The car-lift and car-drop data and that of the grades have been taken from Table VII. (THE ELECTRICAL WORLD, page 396, June 11, 1892). Test car No. 3 was more heavily loaded than the others; otherwise the general conditions of the tests were essentially the same.

Performance of Other Neversink Cars Under Various Conditions.—Before presenting the complete results and plot of the station, car and route data of the test of the special car No. 4, made by the authors, it will be interesting to give some results of the test of cars Nos. 2 and 3 referred to above. These cars are alike in their motor equipment, already described, and are of equal weight, 22,000 pounds, but the seats of No. 4 are somewhat differently arranged from those of Nos. 2 and 3, so as to increase its carrying capacity.

$$\text{Traction H. P.} = \frac{\text{Car weight (in thousands)} \times \text{Traction Coefficient (pounds per thousand)} \times \text{Speed (feet per min.)}}{33{,}000}$$

Total car axle H. P. = Lift H. P. + Traction H. P.

The results of Mr. Hewitt's test are given in Table XIII. arranged according to the data which he has kindly furnished.

These tests are intended simply to show the relations of the speed and efficiency under constant load of the cars, for different positions of the regulating switch. For other grades and loads* these values may be very different.

Mr. Hewitt's test given in Table XIII. was made under very unfavorable circumstances, the voltage being extremely variable and unusually low at the time. The test at the fifth switch position was made twice, as the mean voltage during the first was but 328. The current taken by each motor is given and enables the differences in the amounts to be seen.

The test of car No. 3, the results of which are given in Table XIV., was made on a straight portion of track on the 3.5 per cent. grade near the Klapperthal car house. The car was gotten up to full speed before entering the stretch of track selected for the test, and allowed to remain at this speed were taken while the car was going at full speed, and mostly when the switch was on the seventh point, so that the efficiency would be highest under these conditions.

Test No. 6 was made on the portion of the road consisting of successive sharp reversed curves on the declivity on the south side of the mountain. There are 10 curves here varying from 20 to 40 degrees curvature on a 3.64 per cent. grade, making it necessary for the car to run at a slower speed and requiring an almost continual shifting of the regulating switch. This run is the most trying on the route and the efficiency given in the table is very good, especially as the voltage was also low at the time.

From these results the general efficiency of the motor seems to be about 70 per cent., not including the stops and starts, but these latter occupying so small a portion of the time, being few in number, would only affect this value slightly. Cars lightly loaded and running at higher speeds show an efficiency up to 78.5 per cent. at times, and 75 per cent. for long stretches of road, which indicates, if anything, that the general average efficiency of these cars is higher than 70 per cent. For the sake of being inside rather than outside the possibilities, the authors used 70 per cent. as the mean in their deductions in connection

TABLE XV.

PERFORMANCE OF CAR NO. 3 UNDER HEAVY LOADS AND WHEN PULLING TRAILER ON SELECTED PORTIONS OF ROAD.

	Number of test.	Time interval of reading.	Location of car and road data.				Car speed.			Load.		Calculated Mech. H. P. at car axle.				E. H. P. at motor terminals [mean for time intervals].			Calculated efficiency from motor terminals to car axle.	Remarks.
			Character of track.	Grade per cent.	Actual distance passed over during reading in feet.	Approximate location of car during reading.	Lift in ft. per min.	Speed in feet per min.	Speed in miles per hr.	No. of pass'ng'rs.	Total weight of car and load in lbs.	Lift H. P.	Traction H.P.	Total car axle H. P.	Remarks.	Amp.	Volts.	Electrical H. P.		
Car No. 3 under heavy passenger travel.	1.	2m. 8 sec.	One 20° curve; rest straight.	3.5	1,800	Between No. 13 and No. 14 turnout.	29.6	845	9.6	78	32,900	29.3	8.4	37.7	.....	80.5	472	51.0	74%	Notes. Weight of car empty, 22,000 lbs. Traction coefficient taken as 10 lbs. per 1,000.
	2.	.....	On a 35° curve.	3.5	.....	Near No. 13 turnout.	29 2	835	9.47	78	32,900	29.1	8.3	37.4	No allowance for increased traction on curve.	91.3	440	53.8	69.5%	Readings taken only at full speed of car. Date test, May 1, 1892.
	3.	2m. 19s.	All curves between 25° to 35°.	3.64	1,925	Between No. 13 turnout and trestle.	30.25	832	9.45	78	32,900	29.9	8.3	38.2	.....	94.7	433	55.0	69.5%	
	4.	1m. 16s.	Slight Curvature. One 35° c'rve.	3.64	1,100	Between trestle and No. 12 turnout.	31.7	871	9.9	78	32,900	31.5	8.7	40.2	.....	88.3	450	53.3	75.3%	
	5.	7m. 10s.	Mostly curves.	3.64	5,600	Trestle to near upper junction.	28.3	782	8.89	50	29,000	25.0	6.9	31.9	.....	83	444	49.5	64.5%	Volts varied from 320 to 550. Normally, with no current, 480. Great variation of speed. Used lower switch positions mostly.
	6.	4m. 3s.	Section entirely of reversed curves, from 20° to 40°.	3.64	2,765	Between No. 11 and 12 turnout. Curves on declivity, so'th side of mountain.	24.8	683	7.77	78	32,900	24.7	6.8	31.5	.....	88	432	51.0	62%	Slow speed. Running mostly on lower switch positions.
	7.	1m. 44s.	Few curves.	3.94	1,322	Between No. 4 and No. 5 turnout.	30.	763	8.67	70	31,800	29.0	7.3	36.3	.....	88.7	435	51.7	68.3%	
Car No. 3 pulling motor car No 4 as trailer.	1.	51 sec.	Straight track.	1.6	700	Below No. 7 turnout, on south side of mountain.	13.2	823	9.5	17 5	24,400 22,700	9.75 9.1	6.1 5.68	15.85 14.78 30.63	Motor-car. Trailer. Total.	75.5	425	43.0	71.3%	Notes. Weight of cars empty, 22,000 lbs. each. Traction coefficient taken as 10 lbs. per 1,000. Readings taken only at full speed of car.
	2.	16 sec.	7° curve.	1.0	254	Below No. 7 turnout, on south side of mountain.	9.5	950	10.8	17 5	24,400 22,700	7.03 6.56	7.03 6.56	14.06 13.12 27.18	Motor-car. Trailer. Total.	60.5	460	37.3	73%	Switch at 7th point. Date of test, April 30, 1892.

The tests were all made under similar conditions and are good average results for this road.

Cars No. 2 and 3 Under Different Positions of the Regulating Switch.—Mr. Hewitt's test was made on the four per cent. grade of the Short Line, between the Upper and Lower Junction, and on a straight portion of track. The speed was taken by the Boyer recorder used in the test referred to in the preceding issue, and the car was started on up grades from full stops. Car No. 3 was weighed on the standard track scales of the Philadelphia & Reading Railroad, at Reading, through the courtesy of the superintendent, Mr. G. D. Whitcomb. Its weight was 22,075 pounds, and Car No. 2, the one used by Mr. Hewitt, being of identical equipment and construction, was taken at the same weight. The weight of the observers on board the car at the time of the test was based on their average weight, so that that of the cars has been taken uniformly at 22,000 pounds, which is sufficiently accurate for practical purposes. A traction coefficient of 10 pounds per 1,000 has been taken, because it is the value ordinarily met with in similar electric traction work.

The car axle horse power was computed as that power required to propel the car up the given grade at the given speed. It is made up of two quantities, namely, the power required to lift the car a distance due to the difference of level on grade, and that required to propel it along a horizontal distance corresponding to that grade and speed. These have been termed respectively the "Car Lift H. P." and "Traction H. P." The following formulæ were used:

$$\text{Lift H. P.} = \frac{\text{Car weight (pounds)} \times \text{Lift (feet per minute)}}{33{,}000}$$

till after leaving it. The mean speeds of the car were calculated from the observed time and the known length of track.

The fifth and sixth notches should give practically the same results, but Mr. Hewitt's values are lower because the voltage was so much lower. The speed of the fifth, sixth and seventh notches should be also nearly the same, but for the reason of the voltage, Mr. Hewitt's speeds are lower than those given in Table XIV. This latter test was made under the very best conditions, namely, dry weather, straight and well-laid T-rail track, $\frac{6}{10}$ to $\frac{7}{10}$ rated load on motors, high speed, and the voltage between 475 and 500, which is the pressure for which the motors were calculated, and it is therefore not surprising that the results show such a good efficiency.

Car No. 3 with Heavy Loads and Pulling Trailer.—Table XV. contains the results of readings taken on the car at certain points along the road, while the car was in regular service, during heavy travel; and also the results of a trial of car No. 3 lightly loaded, pulling motor car No. 4 as a trailer. These results are also from the tests made with the electrical engineering students of the Johns Hopkins University, April 30, 1892, already referred to, and are inserted here as being interesting in connection with the special test of the road made by the authors, Aug. 17-18, 1891. It is apparent that the cars did very well under these conditions, but it must be borne in mind that the readings with the "Test of the Power Plant" (THE ELECTRICAL WORLD, pages 5 and 6, July 2, 1892).

The traction coefficient changes very much with the curvature of the road and probably 10 pounds per 1,000 is too high a value for straight tracks; since the efficiency of the motors is invariably higher on straight portions of track when the speed and electrical horse power vary but slightly. This traction coefficient is a very uncertain quantity, and but little reliable data is at hand about it; yet for the sake of comparison the value given above has been used in these results, as it seems to be that most generally accepted for this class of traction work.

*For efficiency tests of street car motors at different positions of the switch and under various loads see a paper read before the American Institute of Electrical Engineers, Chicago, on "Electric Railway Motor Tests," by Prof Shepardson and Mr. Burch, printed in THE ELECTRICAL WORLD, July 9, 1892.

TABLE XVI.

SPEED OF REGULAR PASSENGER CARS ON USUAL ROUND TRIP.

	Including stops.	Excluding stops.
Ninth and Penn to Klapperthal (over the mountain)	9.8	10.9
Klapperthal to Ninth and Penn (via Short Line)	8.1	10.
Round trip, Ninth and Penn and return	8.75	10.5*
RUNNING TIME.		
Ninth and Penn to Klapperthal (over the mountain)	42¾ min.	38½ min.
Klapperthal to Ninth and Penn (via Short Line)	30¼ min.	24½ min.
Stop at Klapperthal	4 min.	
Round trip, Ninth and Penn and return	1 hr. 17 min.	1 hr. 3 min.

Stops for few passengers require from ¼ to ½ minute.
Stops at regular stations require from ½ to 1½ minutes.
Stops due to connections at Junctions are about 4 minutes.
Stops at Klapperthal terminal are about 4 minutes.

*Compare this with value given in Table XII.

Test of Two 6,500-Watt Westinghouse Transformers.

BY DR. JOHN HOPKINSON.

Before giving any of the results of the tests I have made with your* transformers it will be well to explain the methods of experiment adopted. The instantaneous value at any epoch in the period of the difference of potential between any two points of a circuit in which the potential difference is varied periodically is made effective on the measuring instrument by means of a rotating contact maker attached to the shaft of the alternate current generator. The contact maker was constructed for the King's College laboratory by Messrs. Siemens Brothers. It makes contact once in each revolution for a period of about three-quarters of a degree, and breaks it for the rest of the revolution. It is entirely insulated, and so can be connected to any part of the circuit. The position of the contact can be varied, and the variations be read off on a graduated circle of 13½ inches diameter divided into degrees, and by estimation the variation can be read to one-tenth of a degree. The two points between which it is desired to measure a potential difference are connected through the contact maker to a condenser and a quadrant electrometer as shown in Fig. 1, in which *A* and *B* are the points, the potential difference of which at a stated epoch is to be measured, *C* the revolving contact maker, *D* the reversing switch of the electrometer, *E* the condenser of which the capacity can be varied, *F* the quadrant electrometer. It is evident that the quadrant electrometer will give a reading proportional to the potential difference of *A* and *B*, when *C* makes contact. If there were no leakage it would at once give this potential. It is to obviate the effect of leakage that the condenser is introduced, and the amount of the effect was determined by varying the condenser thus: When the condenser had capacity 1, 0.5 and 0.2 microfarads the readings of the electrometer for a given potential difference of an alternating current at the position in the period of maximum electromotive force were 138, 136 and 132 respectively. The rate of loss of potential will be proportional to the reciprocal of the capacity, whence we infer that the true reading, if insulation were perfect, would be 139½, and hence the readings are always corrected by adding one per cent. When the potential difference was too great for the electrometer it was reduced in any desired ratio by two considerable resistances introduced between the points to be measured in the usual way. (Fig. 2). The potential difference may, of course, be measured in other ways. An ordinary voltmeter may be placed between *A* and *B*, in which case it must be standardized with the contact-breaker in circuit; and it will depend for its constant on the duration of the contact, which may vary. Further, it gives, not the difference of potential at any definite epoch, but the mean difference for the whole time of the contact. The condenser may be used and its potential be measured by discharge through a galvanometer; this is open to the objection that if there be any leakage the result will depend on the time at which the contact is broken by the condenser key in relation to the time at which it was made by the revolving contact maker. Lastly, a Clark cell may be used, by a method which Major Cardew pointed out to me, (Fig. 3), the resistance being adjusted till there is no deflection. This is open to the same objection as the first, namely, that it gives the mean of the potential differences which occur during the contact. By making use of the first-mentioned method, we have the means of measuring accurately any potential difference at any epoch of the period, and of knowing the epoch.

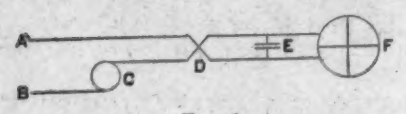


Fig. 1.

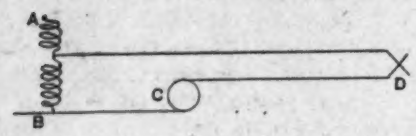


Fig. 2.

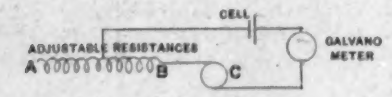


Fig. 3.

Fig. 4.

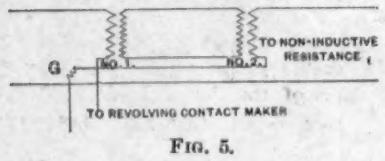


Fig. 5.

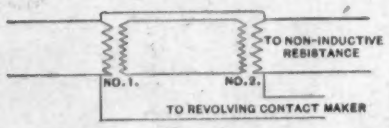


Fig. 6.

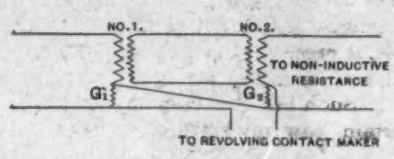
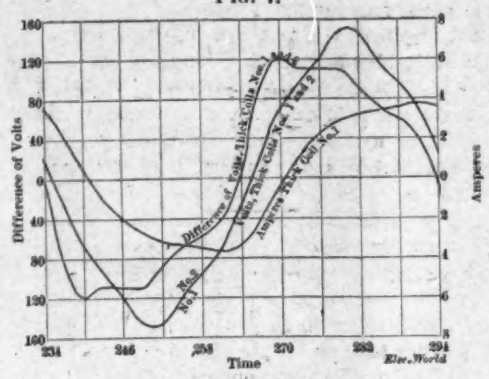
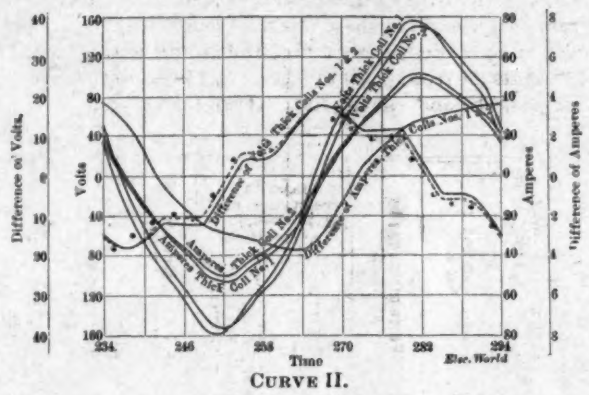


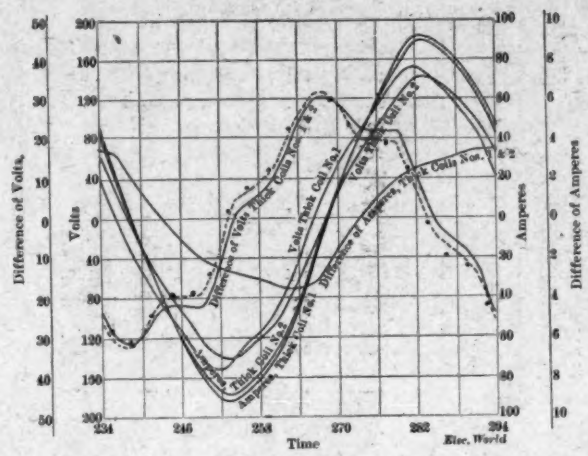
Fig. 7.



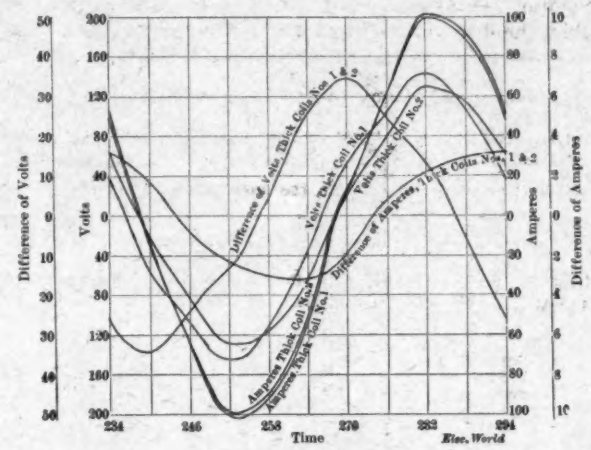
Curve I.



Curve II.



Curve III.



Curve IV.

But the mean difference for the whole time of the contact. The condenser may be used and its potential be measured by discharge through a galvanometer; this is open to the objection that if there be any leakage the result will depend on the time at which the contact is broken by the condenser key in relation to the time at which it was made by the revolving contact maker. Lastly, a Clark cell may be used, by a method which Major Cardew pointed out to me, (Fig. 3), the resistance being adjusted till there is no deflection. This is open to the same objection as the first, namely, that it gives the mean of the potential differences which occur during the contact. By making use of the first-mentioned method, we have the means of measuring accurately any potential difference at any epoch of the period, and of knowing the epoch.

For these experiments, two transformers intended to be identical were available, each transforming between 2,400 and 100 volts. It was most convenient on account of the resistance available to couple these transformers up from 100 to 2,400 in the first or No. 1 transformer, then down from 2,400 to 100 in the second or No. 2 transformer, and to take up the energy from the second in a non-inductive resistance. The arrangement is shown in Fig. 4.

The obvious way in returning the efficiency of the combination would be to measure, at various epochs of half a period, the potential differences of the terminals of the machine and the current passing in the No. 1 transformer; in like manner, at the same epochs, to measure either the potential differences of the current passing to the non inductive resistance, thence to deduce the power supplied to the first transformer and taken from the second. This would be open to certain objections; we are comparing two nearly equal magnitudes and desire their ratio; the ratio will be afflicted with the full error arising from an error in the determination of either magnitude, and such errors may be material, as the observations are not simultaneous, and conditions may change between one series of observations and another.

These objections are avoided by the method adopted. The current from No. 2 is observed at certain epochs, the difference of current between No. 2 and No. 1, and the difference of potential difference of No. 2 and No. 1 at the same epoch. These give the currents and potentials of No. 1 at the same epochs as the corresponding determinations of No. 2, and the difference will only be afflicted with the proportion of error of those differences. For example, suppose the efficiency of the combination were 90 per cent., and the possible error of determination of power 1 per cent, our result might be anything from 88 per cent. to 92 per cent. if made in the obvious way, but if made by differences the maximum loss would be 10.1 per cent., and the possible least determination of the efficiency would be 89.8 per cent. The method is essentially similar to the method I described* and subsequently used for testing dynamos. The measurements for difference of potential differences are made as in Fig. 5. For current differences (Fig. 6), where *G* is a known small non-inductive resistance, the two currents will, of course, slightly disturb each other, but this is readily allowed for in the calculations.

Another method would be to couple them as in Fig. 7, G_1 and G_2 being equal non-inductive resistances. This arrangement is quite free from disturbance, but requires two resistances adjusted to exact equality. A single transformer can be tested in the same way, though, in this case reliance must be placed upon resistances to reduce the current of the low potential coil, and to reduce the potential

TABLE II.

Leads of exploring brush on divided circle.	Current No. 2. Thick coil. Observed deflection.	Current No. 2. Thick coil. Corrected deflection.	Current No. 2. Thick coil. Amperes.	Current No. 1. Thick coil. Current difference. Thick coils, Nos. 1 and 2. Observed deflection.	Current difference. Thick coils, Nos. 1 and 2. Corrected deflection.	Current difference. Thick coils, Nos. 1 and 2. Volts.	Current No. 1. Thick coil. Amperes.	Current No. 1. Thick coil. Amperes.	Mean of currents in Nos. 1 and 2. Thick coils.	Potential No. 2. Thick coil. Volts.	Potential No. 2. Thick coil. Square of volts ÷ mean² = 104.	Potential difference No. 1. Thick coil. Potential difference. Thick coils. Nos. 1 and 2. Observed deflection.	Potential difference No. 1. Thick coil. Potential difference. Thick coils. Nos. 1 and 2. Corrected deflection.	Potential difference No. 1. Thick coil. Potential difference. Thick coils. Nos. 1 and 2. Volts.	Potential difference No. 1. Thick coil. Volts.	Potential difference No. 1. Thick coil. Square of volts ÷ mean² = 107.4.	Mean of potential in Nos. 1 and 2 thick coil.	Watts supplied to No. 1.	Watts given out by No. 2.	Loss by resistance and probably waste field. Resistance.	Loss by resistance and probably waste field. Correction allowed for, probably waste field.	Loss by hysteresis and local currents.	Difference of potential due to waste field.
267	2 5	2.5	+ 0.6	189.5	189.0	+ 3.7	− 2 9	− 2.3	− 0.8	+ 5.6	31	315.0	308 0	+ 18.2	+ 23.8	566	+ 14 7	− 55	+ 3	0 62	− 14 62	− 42 6	+ 18.2
270	65.0	65 0	+ 16.0	77.0	77.0	+ 1.5	− 1.2	+ 14.8	+ 15.4	+ 51.9	2,694	278.0	273.0	+ 16.1	+ 68.0	4.624	+ 60.0	+ 1,006	+ 890	8 7	+ 239 2	− 72 0	+ 15.5
273	108.5	108 5	+ 26.7	28.0	28.0	− 0 6	+ 9.4	+ 27.1	+ 36.9	+ 83.6	6,989	196 5	195.0	+ 11.5	+ 95.1	9,044	+ 89.3	+ 2,577	+ 2,332	26.6	+ 289.7	+ 35 7	+ 10.5
276	145.0	145.0	+ 35 6	99.0	99.0	− 1.9	+ 1.5	+ 37.1	+ 36.3	+ 110.3	12,165	99.0	197 2	+ 11.6	+ 121.9	14.86	+ 116.1	+ 4,523	+ 3,927	48 5	+ 372.5	+ 174 1	+ 10.3
279	186.0	186.0	+ 45.7	152.5	152.5	− 3.0	+ 2 4	+ 48.1	+ 46.9	+ 141.1	19.910	203.0	201.2	+ 11.9	+ 153.0	23,405	+ 147.1	+ 7,359	+ 6.448	80.9	+ 477 2	+ 353.0	+ 10.2
282	205.0	203.2	+ 49.9	186.0	186.0	− 3.7	+ 2.9	+ 52.8	+ 51.3	+ 153.6	23,592	61 0	61.0	+ 3.6	+ 157.2	24,710	+ 155.4	+ 8,300	+ 7,665	96.8	+ 17.9	− 45 .6	+ 1 7
285	184 0	184.0	+ 45.2	203.0	201.2	− 4.0	+ 3.1	+ 48.3	+ 46.7	+ 138.5	19,181	73.0	73.0	− 4 3	+ 134.2	18,009	+ 136.3	+ 6,482	+ 6.26	80.3	− 281 3	+ 422.5	+ 6.0
288	154 0	154.0	+ 37.8	220.0	218 0	− 4.3	+ 2.4	+ 41.2	+ 39.5	+ 114.9	13,202	75.0	75.0	− 4.4	+ 110.5	12,210	+ 112.7	+ 4,552	+ 4.343	57.5	− 231.3	+ 383.0	− 5 9
291	123 0	123.0	+ 30 2	234.5	235 5	− 4.6	+ 3.6	+ 33.8	+ 32 0	+ 90.6	8,208	126.5	126.5	− 7 5	+ 83.1	6.9 4	+ 86.9	+ 2,808	+ 2,736	37 7	− 277.7	+ 312.8	− 8.7
294	67.7	67.7	+ 16.6	237.0	234 0	− 4.6	+ 3.6	+ 20.2	+ 18.4	+ 47.7	2,275	252.0	248.5	− 14 7	+ 33.0	1,089	+ 40.3	+ 666	+ 792	12.5	− 283 0	+ 145.1	− 15 4
											108,247					115,424		38,218	35,236	449.5	371.6	2,162.4	
																		92 2%					
																		298.2			298.3		

[*This is a report made to the Westinghouse Electric & Manufacturing Company, and is reprinted from *The Electrician*, London.—Eds. E. W.

Proceedings of the Institution of Civil Engineers, Vol. LXXXIII., p. 235, and *Transactions of the Royal Society*, part I., p. 347 (1886).

of the high potential coil in the ratio of the number of windings in the two coils.

The current was throughout generated by a Siemens alternator with 12 magnets, run at a speed between 830 and 840 revolutions per minute, which gives a frequency of 5,000 per minute, or 83 to 84 per second.

The first experiment tried* was with the two transformers coupled, but with No. 2 transformer on open circuit, or on nearly open circuit, for a high resistance for purposes of measurement was interposed between the terminals of the low resistance coil of No. 2 transformer. The actual results are given in Table I., and are expressed in curve 1.

TABLE I.

Leads of exploring brush on divided circle	Current No. 1. Thick coils.	Potential No. 2. Thick coils.		Potential No. 1. Thick coils.		Square of volts. $\sqrt{\text{mean}^2} = 101.9$	Watts s'pplied to No. 1.
	Amp'res.	Volts.	Square of volts. $\sqrt{\text{mean}^2} = 101.1$	P. D. Sec Nos. 1 & 2. Volts.	Volts.		
267	− 2.2	+ 25.4	645	+0.9	+ 26.3	692	− 57.9
270	− 0.3	+ 70.2	4,928	+1.2	+ 71.4	5,098	− 21 4
273	+ 1.1	+ 95 3	19,082	+1.1	+ 96.4	9,292	+106.0
276	+ 2 1	+120.4	14,496	+1.1	+121.5	14,761	+255.1
279	+ 2.8	+147 7	21,816	+1.1	+148.8	22,140	+416 6
282	+ 3.2	+147 2	21,668	+ 0.9	+148.1	21,935	+473.9
285	+ 3.4	+119.8	14,351	+0.7	+120.5	14,520	+409.7
288	+ 3 5	+ 97.8	9,565	+0.6	+ 98 4	9,683	+344.4
291	+ 3.7	+ 71.3	5,084	+0.4	+ 71.7	5,140	+260.3
294	+ 3 5	+ 26.0	676	+0.3	+ 25.97	674	+ 90.9
	....	....	102,311		....	103.935	2,282.6

Tables II., III. and IV. give the results for half power, nearly full power, and full power, and the sets of curves of corresponding numbers give the results of the table. In these tables the first column gives the position of the contact brush in degrees, so that 60 on this scale corresponds with a complete cycle. Three degrees are thus $\frac{1}{83.3 \times 20}$ of a second. The second column of Table I. is the current in the thick coil of No. 1 transformer, as determined by the difference of potential at the two ends of a non-

TABLE III.

Leads of exploring brush on divided circle.	Current No. 2 thi'k coil	Current No. 1. Thick coil.		Mean of current in Nos. 1 and 2. Thick coils.	Potential No. 2. Thick coil.		Potential difference No. 1 Thick coil.			Mean of potential in Nos. 1 and 2. Thick coils.	Watts supplied to No. 1.	Watts given out by No. 2.	Loss by resistance, and probably waste field.		Loss by hysteresis and local currents.	Difference of potential due to waste field.
	Ampères.	Current difference secondaries Nos. 1 and 2 Ampères.	Ampères.		Volts.	Square volts $\sqrt{\text{mean}^2} = 98.2$	Potential difference Thick coils Nos. 1 and 2. Volts.	Volts.	Square volts $\sqrt{\text{mean}^2} = 104.3$				Resistance.	Losses unaccounted for, probably waste field.		
267	−15.0	−3.1	−18.1	−16.5	− 20.6	424	+31.2	+ 10.6	112	− 5.0	− 192	+ 309	10.4	− 525.1	+ 15.5	+31.8
270	+15.0	−1 6	+13.4	+14.2	+ 26.5	702	+29.7	+ 56 2	3,305	+ 41.3	+ 753	+ 397	7.6	+ 414 1	− 66.1	+29.2
273	+38.5	− 2	+38.3	+38.4	+ 63.0	3,969	+22.7	+ 85.7	7,345	+ 74.3	+ 3,282	+ 2,425	55.9	+ 815.7	− 14.9	+21.2
276	+57.1	+1.0	+58.1	+57.6	+ 91.8	8,427	+21.7	+113.5	12,880	+102.6	+ 6,595	+ 5,242	125.7	+1,124.3	+102.6	+19.5
279	+75.2	+1.9	+77.1	+76.1	+120.2	14,440	+22.2	+142.4	20,280	+131.3	+10,980	+ 9,038	219.4	+1,470.1	+249.5	+19.3
282	+88.8	+2.5	+91.3	+90.0	+141.6	20,050	+11.0	+152.6	23,285	+147 1	+13,930	+12,575	307.0	+ 683.0	+367.7	+ 7.6
285	+86.9	+2.8	+89 7	+88.3	+138.1	19.070	− 2.3	+135.8	18,440	+136.9	+12,180	+12,000	295.4	− 498.5	+383.3	− 5 7
288	+77.5	+3.1	+80.6	+79.0	+122.4	14,980	− 6.2	+116.2	13,502	+119.3	+ 9,365	+ 9,486	236.4	− 726.2	+369.8	− 9.2
291	+64.6	+3.4	+68.0	+66.3	+101.0	10,200	−11.8	+ 89.2	7,957	+ 95.1	+ 6,066	+ 6,524	166.5	− 948.8	+323 3	−14 3
294	+42.9	+3.5	+46.4	+44 6	+ 65.5	4,290	−24.2	+ 41.3	1,705	+ 53.4	+ 1,916	+ 2,810	75.4	−1,154.6	+186 9	−25.9
						96,552			108,811	—	64,875	60,806	1,499.7	654.0	1,917.6	
											93. 73%					
											406,9				407.1	

inductive resistance in which the current passes. The third column is the potential difference of No. 2 transformer, a direct determination. The fourth column is solely for the purpose of determining the square root of the mean of the squares of the third column. This column is a direct determination of the difference of potential of No. 1 and No. 2 obtained in the manner explained with reference to Fig. 5.

The sixth column is the deduced potential difference of the terminals of the thick wire of No. 1 transformer, being the sum of the third and fifth columns. The seventh column, like the fourth, is merely for the purpose of determining the square root of the mean of the squares of column six, while the eighth gives the rate at which power is given out or received by the pair of transformers.

(To be concluded.)

* So far as I know, the first discussion of endless magnetic circuit transformers, based on the actual properties of the material, is in a note by myself (*Proc. Roy. Soc.*, Vol. XLII, and *The Electrician*, Vol. XVIII., p 421). D finite results were obtained by methods generally similar to those now used by Prof. Ryan (THE ELECTRICAL WORLD, Dec. 28, 1889). The theory of transformers is well set forth by Prof. Fleming (*The Electrician*, April 22 and 29, 1892).

Financial Aspects of Electr ic Lighting.*

BY S. J. PARKER.

It is extremely gratifying to look back and realize in how short a time we have emerged from Egyptian darkness into a light equalling Luna's softest rays, and coping with the brilliant midday sun; at the same time the question will naturally present itself, does it pay as a commercial investment? do the parties who have invested their millions in giving the public this brilliant illuminant receive an adequate return for such investments? I am afraid the results prove otherwise. Mistakes were undoubtedly made and money foolishly squandered in the initiation of many plants, which if the work had to be done over again to-day would not be repeated; at the same time, even with the knowledge that experience has taught us, are we realizing or can we realize, at present prices, the golden harvest which the manufacturer, or rather his agent, pictured in such glowing colors? Such has not been my experience, and desiring to ascertain how my brethren in other parts of the country had fared, I, a few months ago, addressed to them certain questions, from which I gathered that out of 25 stations with a capital of about one million dollars, 14 of them had paid dividends (in many instances not until the third year) of from four to eight per cent., while the remaining eleven had not paid one cent of a dividend, and some of them had not met expenses. Of these twenty-five plants, thirteen, with a capital of over $700,000, were using steam as their motive power, of which only five paid any dividend. Three were run partly by water and partly by steam, of which two paid a dividend; nine were run by water, and eight of them paid dividends. From these returns I gathered that out of a capital of nearly one million dollars, dividends had been declared on only about $400,000, while the investors of the remaining $600,000 had not received one cent of interest for their money, and this state of things had existed from one to three years. In analyzing these returns I found that the small plants run by steam paying a dividend were getting for their arc lights (of from 1,200 to 2,000 c. p.) twenty-five cents for midnight, and about forty cents for all night lights, while the plants run by water power could declare a profit on prices ranging from 10 per cent. to 12½ per cent. less.

More recently my friend, Mr. Yule, of Guelph, obtained similar results. He found that out of 52 stations only 30 were paying any dividend, of which 15 were associated with other business, carried on during the day, and the lamps shut off at midnight; the remaining 22 were not realizing any profit, and some were eating up their capital. Discouraging remarks were made by many of the 52 who answered the questions, so much so that I am led to the conclusion that to many who have engaged in the electric light business it has not proved the Eldorado which their imagination so fondly pictured. Such a state of affairs is unfortunate; surely a remedy can be found.

It is quite evident that the price received for the quality and quantity of light supplied is entirely inadequate to the outlay necessary for the production of such light, and the sooner this is understood by municipal corporations and others requiring lights the sooner will the business of electric lighting be placed on a sound commercial basis. While discountenancing any attempt at forming monopolies, still I think the time has arrived when there should be a closer union of the central station men as well as the manufacturer, whereby the senseless and ruinous competition so frequently engaged in may be avoided and contracts obtained at a fair remuneration. In cities using large numbers of lights and employing the plants 365 nights in the year the present prices may afford fair profits, but not enough, I am afraid, to provide a sinking fund to meet the necessary depreciation in plant. A field is, however, opening up for city plants which is not available to those situated in small towns and villages. The development of the transmission of electricity for power has within the last few years made considerable progress, and its use may fairly be counted upon in the near future in displacing horse power on street railways, and the motor run by electric light plants during the day may find employment in a thousand and one places where hitherto steam, horse or man power has been employed.

These advantages do not, however, and will not, for years to come, extend to our towns and village plants. Here we find installations of from 15 to 30 arc lamps operated by steam power, running to midnight, and employed not probably more than an average of *six hours* out of twenty-four and only getting from 15c. to 20c. per lamp per night for 300 nights in the year.

It does not require the wisdom of a Solomon to recognize the fact that no dividends can be expected in such cases, and that it is only a matter of time, and a very short time at that, when either better prices must be obtained or the plants shut down.

Even in the neighboring republic, where much better prices are obtained, we find that as a commercial investment it has not met with that success which would warrant capitalists in again investing in like enterprises. From information I received I gather that our electric light brethren in the States, even with big prices, are not doing a great deal better in the way of paying dividends than we in Canada are.

I submit a few of the prices obtained on the other side, from an excellent table prepared early in 1892 by Mr. Chas. Baillairgè, engineer of the city of Quebec. The prices are reduced to the basis of all night, and every night in the year.

Name of City.	No. of lights.	Price per night, in cents.
Albany, N. Y	600	43
Boston, Mass	1,125	40
Buffalo, N. Y	1,700	40
Detroit, Mich	827	38½
Milwaukee, Wis	650	31¼
Minneapolis, Minn	500	48½
New Orleans	75	54¾
New York, several companies, about	2,000	40 to 60
Philadelphia, several companies, about	1,560	30 to 55
Rochester, N. Y	1,274	27
San Francisco, Cal	125	110
Syracuse, N. Y	522	30
Washington, D. C	206	61½

The following prices of Canadian plants I selected from the answers I received to inquiries made:

Cities and Towns.	No. of lamps.	Price per night, in cents, reduced to basis of all night and 365 nights.
Brockville	29	35
Brantford	29	28¾
Belleville	41	28¾
Chatham	49	33
Hamilton	310	28
Kingston	—	28
London	275	28½
Ottawa	300	30
Owen Sound	30	24½
Quebec	308	22
Sherbrooke	52	34
St. Catherines	62	30
St. John, N. B	220	25½
St. Johns, N. F	43	47½
St. Thomas	29	28
Toronto	900 to 1,000	29¾
Winnipeg	100	75

TABLE IV.

Leads of exploring brush on divided coil.	Current No. 2. Thick coil.			Current No. 1. Thick coil.					Mean of current in Nos. 1 and 2. Thick coils.	Potential No. 2. Thick coil.		Potential No. 1. Thick coil.				Mean of potential in Nos. 1 and 2. Thick coils.	Watts supplied to No. 1.	Watts given out by No. 2.	Losses by resistance, and probably waste field.		Loss by hysteresis and local currents.	Difference of potential due to waste field.
	Observed deflection.	Corrected deflection.	Ampères.	Current difference. Thick coils. Nos. 1 and 2. Observed deflection.	Corrected deflection.	Volts.	Ampères.	Ampères.		Volts.	Square of volts. $\sqrt{\text{mean}^2} = 90.9$	Potential difference. Thick coils. Nos. 1 and 2. Observed deflection.	Corrected deflection.	Volts.	Volts.	Square of volts. $\sqrt{\text{mean}^2} = 98.4$				Resistance.	Losses unaccounted for, probably waste field.		
270	59	59	+ 14.3	107	107	+ 2.1	− 1.7	+ 12.6	+ 13.4	+ 21.3	454	355	345	+ 33.9	+ 55.2	3,047	38.3	695	304	6.8	+ 447.5	− 65.1	+ 33.4
276	246	252	+ 61.)	57	57	− 1.1	+ 0.9	+ 61.9	+ 61.4	+ 80.7	6,512	256	252	+ 24.8	+ 105.5	11,130	93.1	6 530	4,923	142.8	+ 1,380.2	+ 83.8	+ 22.5
282	427	410	+ 90.3	147	147	− 2.9	+ 2.3	+101.6	+100.4	+130.2	16,950	142	142	+ 14.0	− 144.2	20,790	127.2	14.650	12,928	382.0	+ 1,023.5	+ 315.5	+ 10.2
288	381	369	+ 89.3	188	187	− 3.7	+ 2.9	+ 92.2	+ 90.8	+116.1	13,180	59	59	− 5.8	+ 110.3	12,165	113.2	10,170	10,367	312.3	− 839.0	+ 328.5	− 9 2
294	207	205	+ 49.6	211	209	− 4.1	+ 3.7	+ 52.8	+ 56.2	+ 62.4	3,893	266	262	− 25.8	+ 36.6	1,340	49.5	1,933	3,095	99.3	− 1,420.3	+ 158.4	− 27.7
											41,289					48,472		33,978	31,617	943.2	591.9	820.9	
																		93.05%					
																				472.2		471.2	

* Abstract of a paper read at the first annual meeting of the Canadian Electrical Association.

While not desiring to be considered a pessimist in the matter of electric lighting, I think that the most sanguine will acknowledge that the present condition of affairs cannot last for any length of time. A remedy must be found either in better prices or less cost. The sooner this remedy is found and applied, the better for those whose capital is locked up in this business. We ask no bonanza, but we do contend that capital invested in electric lighting should be as profitable as that employed in other legitimate enterprises.

A Life and Efficiency Test of Incandescent Lamps.*

BY PROFESSOR B. F. THOMAS AND MESSRS. P. MARTIN AND R. H. HASSLER.

Much has been written and said concerning the efficiency of the incandescent lamp and of the relation between its efficiency and the length of life to be expected from it. High efficiency lamps have their advocates and low efficiency lamps have theirs. It is pretty well understood by those whose work has put them in a position to appreciate the facts, that the question as to the choice of the lamps which will have best influence on the profit and loss account of the consumer depends on other things than

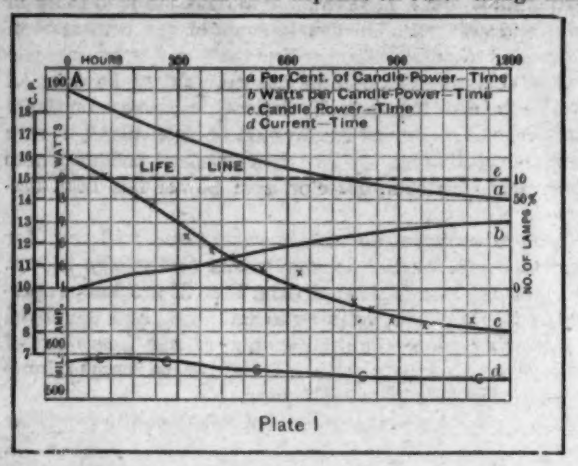


Plate I

first cost, efficiency and life. It is understood by such persons that the cost of producing the current supplying the lamps and the steadiness of voltage maintained on the lines are important factors in the choice, the high efficiency, short life lamp being best under condition of steady voltage and expensive current, and the low efficiency, long life lamp where current is cheap or regulation poor.

The general public, however, does not understand the question so clearly, and unfortunately that part of the literature of the subject which is found in the advertising columns of the electrical press does not tend to relieve the embarrassing ignorance of the buyer. Statements of the marvelously long life of certain lamps are followed in a week by ludicrous accounts of searches for them with a lantern, and of the imminent peril of the country, arising from the exhaustion of our coal supply by the running of such lamps. Again we are startled by statements of the wonderful results attained by lamps of some certain make, as indicated by the number of such lamps which can be maintained at a full brilliancy by the expenditure of a horse power. But immediately it is said that the insane asylums of the country are full of station managers and stockholders, whose cases have become hopeless through contemplation of the number of such lamps bought during the year. There is as great divergence between the published claims of lamp makers and the statements of the experience of station managers. Makers generally say that they will guarantee 600 hours life for their lamps, and from 10 to 14 or more lamps per horse power, but some station managers insist that they do not get an average of 400 hours life.

Lamp makers have, from necessity, made a study of their own lamps, and of those of other makers also, as to efficiency and life, and they know, better than any one else, the character of the incandescent lamp of to-day. But naturally they, if they say anything on the subject, tell about the good points of their own goods and the bad points of others, and, as naturally, the buying public say that all their statements are questionable. Much good work has been and is being done in college laboratories on lamp efficiencies, and

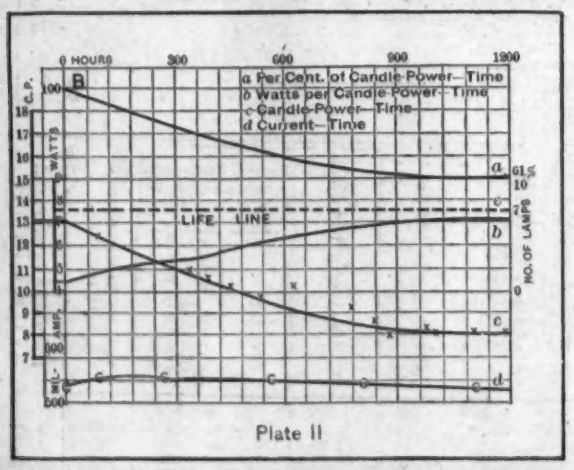


Plate II

the results are published and accepted, but on the equally important question of life the laboratories are silent. The tests of the Franklin Institute stand as a model piece of work, but that work is now eight years old. Farther, the lamps tested at that time were furnished by the makers themselves for the purpose of test. Believing that the public would be interested in the results of a test of commercial lamps, as to both efficiency and life, the writers have carried out such a test and give the results in this paper. The test was made at the Electrical Laboratory of the Ohio State University, Columbus, O., and all expenses incurred were paid by the trustees.

Considering it of prime importance for our object that the lamps tested should be of the same character as those usually sold to consumers, we bought some lamps of regular dealers, as in the usual course of business, and obtained others from lots supplied for central station use. Lamps of the following makes were obtained, no attempt being made to get lamps of any given efficiency of any make: A. B. C., Beacon, Columbia, Economic, Packard, Pennsylvania, Standard, Thomson-Houston, Edison, Perkins, Sawyer-Man, and Steuben. In ordering (through persons purchasing for us in Chicago and New York) we called for ten 110-volt lamps of 16 c. p. in each case, but on receiving the lamps we found three lamps out of ten of one make labeled 111 volts. The three were excluded and seven put in, but another lot of ten of the same make, correctly labeled, was obtained. Ten of another make were received with the original marking, 111 volts in ink, changed by pencil to 110 volts. They were also excluded, and a new lot of ten of that make, correctly labeled, obtained. Ten Sunbeam lamps were divided into two lots of five each, evidently supplied as a sample lot, and were excluded. We could not get others of that make in time to enter the test. There were, therefore, in all 127 lamps, labeled 110 volts and 16 c. p., of 12 well known makes, 17 lamps in two separate lots of one make, and ten each of 11 different makes.

For convenience in making the photometric measurements, the lamps were mounted vertically in horizontal rows of 20 on a light vertical rack, 6 feet high and 20 feet long. The rack was made in the form of ordinary shelving, having five vertical pieces of pine, 4 inches wide and 1 inch thick, and four horizontal strips of the same width, the 4-inch face being horizontal. The whole was rigidly braced diagonally, suspended by strong cords passing over pulleys in the ceiling and counterpoised by weights. This arrangement enabled us to bring each row of lamps to the level of the photometer described below, by raising or lowering the rack, and definiteness of position was secured by spiking to the brick wall of the photometer room two 2 by 4 inch vertical guides, against which the rack was pressed, and fastened each time by stout inclined pins, passed through the diagonal braces into holes bored in the guides.

A system of positive mains was arranged by fastening a

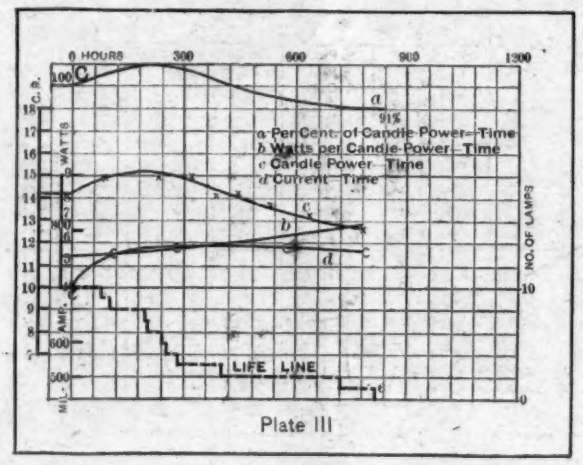


Plate III

No. 2 wire along the face of each horizontal strip in the rack, and joining them at the middle of the rack by a vertical No. 0 wire. A set of negative mains similarly made was placed on the opposite side of the rack. Flexible okonite cable of equivalent section joined the No. 0 vertical wires to the ends of the dynamo mains, fastened to the wall, which point is called the centre of distribution. Porcelain keyless wall sockets were screwed in place on the horizontal rack strips, and joined to the mains on each side by No. 16 wire. All connections were well soldered.

A Thomson centiampère balance provided also with a resistance for obtaining standard potential readings was used as a standard for current and potentials. Its constants had been repeatedly checked by a voltameter, and by Clark cells, and found correct and constant to within one part in one thousand. Two Weston milliampère meters and two Weston voltmeters were used in the current and potential readings on the lamps. The ammeters were graduated to 10 milliampères, readable to one milliampère, and the voltmeters in volts, readable to tenths. The Weston instruments were compared with the Thomson balance at intervals, and found correct, or affected by a small constant error, which was applied as a correction.

Current was supplied to the lamps by a 200-light Thomson-Houston dynamo, of the spherical armature type, which proved to be an excellent machine for the purpose. Owing to the variable speed of the engine, due to varying load and steam pressure, a special automatic regulator was devised and applied to the dynamo, to keep the potential at the centre of distribution constant. This was effected by causing a small motor to slide a contact piece along two vertical german silver wires joined to an extension of the field coil of the dynamo, a current being sent through the motor in one direction or the other as needed, by relay points, the relays being controlled by an indicator attached to wires leading to the centre of distribution. As used, the combination proved very satisfactory, keeping the potential difference at the centre at 110 volts, within a limit of ¼ of a volt either way. It could readily have been set to a smaller margin, but that was not considered necessary.

For the candle power measurements a two candle power Methven screen was used, the gas being passed through a Methven carbureter containing pentane. Its constant was checked by standard candles. Three 32-candle power Edison lamps were used as working standards. Each was checked at intervals by comparison with the Methven screen on a 100-inch photometer bar, a slide wire resistance enabling us to adjust the current through the lamp to a definite strength, which was always the same for a given lamp. The currents used were such as to develop about 18 candle power in the standard lamp. Instead of the usual Bunsen or Leeson disc, we used a Lummer-Brodhun prism, made by Schmidt & Haensch. It gave us much better satisfaction than the best Leeson discs we have been able to obtain.

In front of the test rack and parallel with it was placed a bench with a guiding rail, along which a Weber portable photometer was arranged to slide, so as to be placed succes-

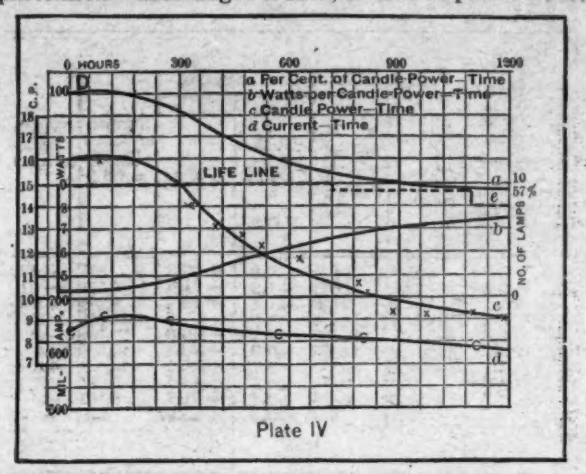


Plate IV

sively in front of each lamp in a row on the test rack. Instead of the little benzine standard lamp which was removed, a 16-candle incandescent called the reference lamp was placed at a distance of about 800 centimetres from the end of the tube to which the benzine standard is attached. In taking the candle power of the lamps under test, the photometer was first placed in front of one of the working standards. By means of a conveniently arranged slide wire resistance, the current through the standard lamp was accurately adjusted to the strength used with it, when its candle power was measured on the standard photometer against the Methven screen. Care was taken that the adjustment of current was right when the measured potential at the terminals of the reference lamp was just 110 volts. Readings of the standard lamp against the reference lamp being taken the photometer was then moved in front of each lamp under test, and readings taken of each against the reference lamp. The candle power of each lamp was then found by comparing these readings with those obtained opposite the standard lamp. The reference lamp being of the same character as those under test, and connected to the same mains, the slight changes in potential allowed by the regulator affected alike the candle power of the reference lamp and the test lamp being read, allowing us to take readings more rapidly than we could have done had it been necessary to adjust and hold the potential at 110 volts.

Before the duration test began the mean horizontal candle power of each lamp was determined in the usual way, and the ratio of this mean to the candle power found when the plane of the ends of the filament was perpendicular to the photometer bar was found, and used as the distribution factor. The lamps were placed on the rack in the same position with respect to the Weber photometer, at a distance of about one metre from its plate, the exact distance of each lamp being measured and used in the calculations on it. All results are expressed in terms of mean horizontal candle power. The unavoidable delays encountered in starting the test made it impossible to determine the spherical distribution without cutting short the time of run which we had set as desirable, viz., 1,200 hours. The duration

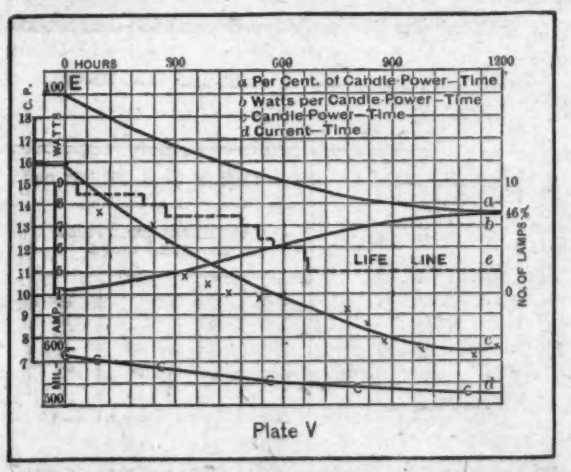


Plate V

test was begun on March 17, and it was necessary to run night and day, Sundays excepted, until the night of May 14, to complete the 1,200 hours. The run began with 77 lamps on the rack. The remaining 50 lamps were received later, and placed on the rack with the others 187 hours after the start.

As the methods used involve nothing particularly new, and have been fully described in print many times, we have considered it unnecessary to do more than state the general outlines, as above.

The object we had in view in undertaking the test was to determine the character of the incandescent lamp as a commercial product, not as a scientific instrument. The number of lamps of each make taken was, of course, too small to base a fair judgment on as to the absolute or relative merit of the lamps generally sold by the makers. For

* A paper read before the American Institute of Electrical Engineers.

that purpose some hundreds of lamps of each make, taken from different lots, would have to be tested, which it was of course impossible for us to do. For this reason we have considered it unfair to the several makers concerned to give their names in connection with the results on their lamps, but have instead designated each make by a letter, and each lamp by a number. We believe, however, that the average of the results of all makes may be taken to represent fairly well the character of the average commercial lamp.

The results of the test are given in the following tables, the values given being in each case the average for a given make of lamp. Table I. gives in the second column the

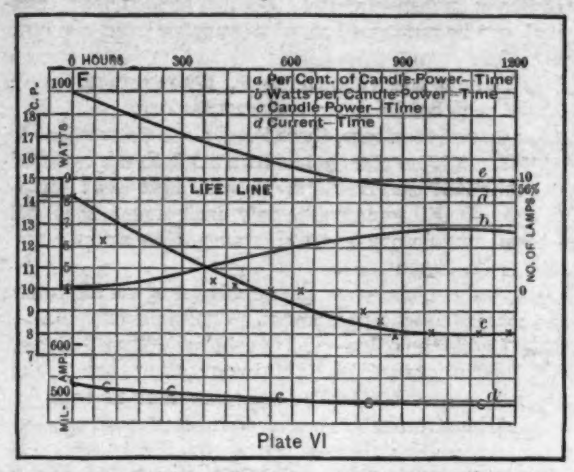


Plate VI

average value of the stributidion factors found for the 10 lamps of make "A," and the average value of the mean horizontal candle powers for those lamps at intervals after the beginning of the duration test, expressed in hours by numbers in the first column. The third column gives corresponding values for the lamps of make "B," and so on. Table I. includes the lamps started March 17. Table II. contains similar data for the lamps started 187 hours later.

TABLE I.

Lamp.	A	B	C	D	E	F	G	K
Distribution factor.	1.05	1.07	1.01	1.11	.089	1.01	1.01	1.02
Hours from start.	C. P.	C. P.	C. P.	C. P.	C. P.	C. P.	C P.	C. P
0	16.0	13.1	14.1	16.1	15.9	14.2	17.1	17.0
93	15.0	12.4	14.8	16.1	13.7	12.1	15.9	16.1
233	13.65	12.4	14.9	16.0	13.1	12.9	16.4	16.5
324	12.2	11.0	14.8	13.9	10.9	10.8	14.5	13.9
392	11.7	10.5	14.0	13.2	10.5	10.4	13.6	13.4
441	11.3	10 2	14.2	12.7	10.1	10.2	13.3	13.1
537	10.9	9.9	13.6	12.3	9.9	10.0	13.0	13.0
637	10.7	10.1	13.0	11.9	9.5	10.1	12.4	12.4
785	9.4	9.2	12.6	10.5	9.1	9.1	11.4	10.9
833	9.1	8.6	All out	10.1	8.5	8.5	10.9	10.3
883	8.6	8.2	....	9.3	7.7	8.0	10.4	9.8
972	8.6	8.3	....	9.2	7.6	8.0	10.4	10.0
1,105	8.6	8.2	....	9.2	7.4	8.0	10.3	9.5
1,190	8.2	8.0	....	9.0	7.5	8.0	10.4	9 6

TABLE II.

Lamp.	L.	M.	N.	O.	P.
Distribution factor.	1.10	1.00	.911	1.00	1.02
Hours from start.	C. P.	C. P.	C. P.	C. P.	C. P.
0	13.2	12.5	14.1	17.0	11.6
71	12 6	12.5	13.5	.....	.....
137	10 7	12.6	11.7	16.4	15.9
205	10.1	11.9	11.0	14 8	13.6
254	9.7	11.8	10.4	14.0	13.0
319	9.3	11.8	10.1	13.3	12.3
450	8.9	11.5	9.4	11.6	11.6
598	7.8	10.6	9.3	10.8	9.7
646	7.6	9.6	8 2	9.6	9.2
696	7.1	9 3	7.9	9.0	8.4
785	7.1	9.4	7.8	9.0	8.7
837	6.8	8.7	7.5	8.3	8.5
1003	7.1	8.8	7.4	8.0	8.1

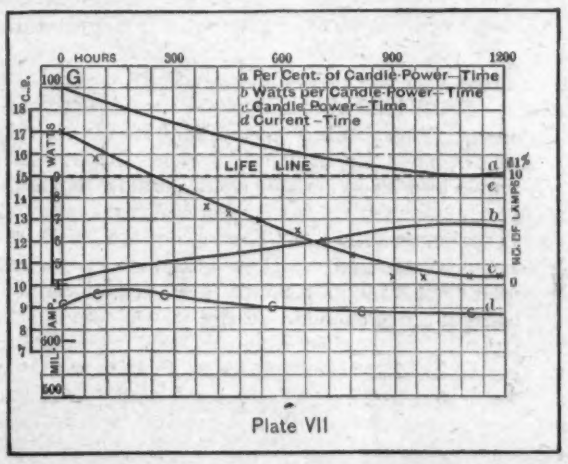


Plate VII

Table III. gives the average current strength found for each make of lamp, at times given in the first column:

TABLE III.

Lamp.	Mean current strength in ampères.												
	A	B	C	D	E	F	G	K	L	M	N	O	P
Hours.													
0	.567	.532	.693	639	.589	.532	.662	.613	.458	.547	.568	.609	.536
100	....	....	....	....	....	....	....	....	.444	.532	.557	.665	.534
107	.575	545	.760	.668	581	.519	.689	.629	....	....	....	....	...
275	.567	.540	.778	.655	.566	.516	.681	....	....	....	....	....	....
380	....	....	....	....	....	....	....	....	.425	.513	.528	615	.511
555	.548	.540	.770	.633	.541	.504	.662	....	....	....	....	....	....
615	....	....	....	....	....	....	....	....	.418	.505	.519	.595	.495
790	.540	.535	.770	.619	.530	498	654	.581	....	....	....	....	....
930	....	....	....	....	....	....	....	....	.417	.500	.508	.585	.476
1,105	.535	.529	.000	.611	.517	.495	.649	.577	..	....	....	....	....

Table IV. gives the mean percentage of original candle-power for each make at times given in the first column:

TABLE IV.

Lamp.	A	B	C	D	E	F	G	K	L	M	N	O	P	Average.
Hours.	%	%	%	%	%	%	%	%	%	%	%	%	%	%
0	100	100	100	100	100	100	100	100	100	100	100	100	100	100
100	93	94	106	101	92	93	95	93	87	100	87	95	107	95.6
200	86	89	109	99	84	86	90	87	78	98	79	87	97	90
300	79	83	106	93	77	81	86	83	72	94	72	80	86	84
400	74	80	102	82	72	77	81	78	67	90	67	72	78	78.4
500	69	73	98	75	66	70	77	74	63	86	63	66	71	73
600	64	70	94	70	61	66	73	70	59	80	60	60	65	68.6
700	61	67	91	66	57	62	70	67	55	75	56	55	60	64.7
800	58	64	90	63	53	59	66	63	54	73	55	51	58	62
900	55	63	All out	60	51	57	63	59	53	70	53	49	56	57.4
1,000	54	62	.....	58	49	56	62	58	54	70	52	47	57	56.6
1,100	52	61	.....	57	47	56	61	57	...	...	...	...	...	55.8
1,200	51	61	.....	56	47	56	61	57	...	...	...	...	...	55.4

Table V. gives the average watts per mean horizontal candle power for each make, at times given in the first column:

TABLE V.

	Watts per mean horizontal candle power.													
	A	B	C	D	E	F	G	K	L	M	N	O	P	Av.
Hours.														
0	3.9	4.4	5.4	4.3	4.1	4.1	4.2	3.9	3.8	4.8	4.4	3.9	4.0	4.2
100	4.3	4.8	5.6	4.5	4.4	4.3	4.6	4.3	4.2	4.7	4.9	4.5	3.8	4.5
200	4.6	5.1	5 6	4.5	4.7	4.6	4.9	4.6	4.6	4.7	5.3	4.9	4.1	4.8
300	4.9	5.4	5.7	4.8	5.0	4.9	5.0	4.8	4.9	4.8	5.7	5.2	4 5	5.0
400	5.2	5.6	5.9	5 3	5.4	5.1	5.3	5.0	5.2	4.9	6.1	5.4	4.9	5.3
500	5.5	6.1	6 2	5.8	5.7	5.5	5.5	5.2	5.5	5.1	6.3	5.8	5.2	5 6
600	5.8	6.4	6.4	6 1	6.1	5.8	5.7	5.4	5.8	5.5	6.7	6.3	5.6	5.9
700	6.1	6 7	6.6	6.4	6.5	6 1	6.0	5.6	6.1	5.8	7.0	6.9	6.1	6.3
800	6.4	6.9	6.7	6.7	7.0	6.4	6 3	5.9	6.3	5.9	7.2	7.4	6.2	6.6
900	6.7	7.0	....	7.0	7.2	6.6	6.6	6.2	6.4	6.1	7.4	7.7	6.3	6.8
1,000	6.8	7.1	....	7.2	7.4	6.8	6.7	6.4	6 2	6.1	7 5	7.9	6.2	6.8
1,100	7.0	7.2	....	7.3	7.6	6.7	6 8	6.5	..	....	....	....	....	7.0
1,200	7.1	7.2	..	7.4	7.6	6.7	6.7	6.5	....	....	....	....	....	7.0

From the data given in the tables plates I. to XIII. are constructed. Each plate refers to a single make of lamp. Plate I. gives curves relating to the average lamp of make *A*. In it curve *a* gives percentage of initial candle power, *b* gives watts per candle power, *c* gives candle power, *d* gives current strength, and *e* gives number of lamps burning. The time scale is common to all the curves. The curves are lettered alike, are drawn to the same scale, and have the same starting points in each of the plates. The make of lamp referred to is indicated by the letter in the upper left hand corner of each plate. Curves *c*, *d* and *e* are plotted from observed values, but curves *a* and *b* are obtained from points 100 hours apart on *c* and *d*, combined, of course, with the voltage 110 for *b*.

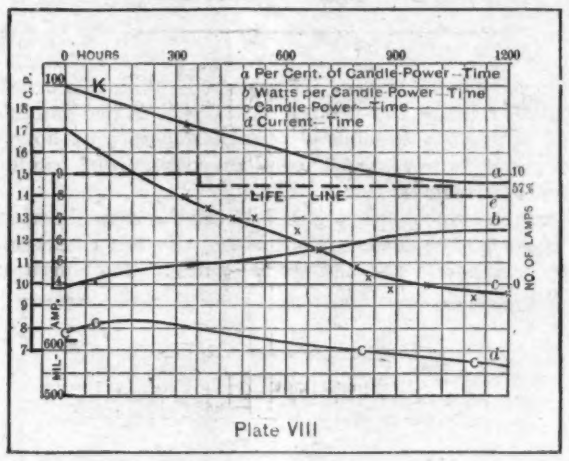


Plate VIII

Want of time, due to the pressure of other duties, prevented our taking readings as often as we would like to have done, and prevented also the examination of a number of points of interest which developed as the test progressed. For the same reason we are unable to include the data and curves for the individual lamps.

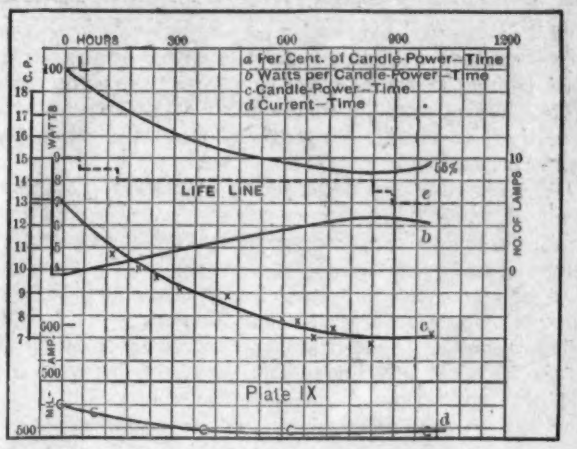
Thirty-one lamps in all were broken, distributed as follows: All of the C's (10), 2 D's, 8 E's, 2 K's, 4 L's, 1 M and 2 N's. All the lamps of A, B, F, G and O makes survived, the O's for 1,013 hours, the others for 1,200. The average life of the C's was 336 hours.

Plate XIV. gives two sets of curves. One set gives the curve of general average of percentage of initial candle power with respect to time, derived from the averages of the several makes, and beside it, the curve of the make which showed highest percentage throughout, marked min. drop, make M, and also the curve showing lowest percentage, marked max. drop, make L. The other set shows the general average of watts per candle power, and also the curves of the two makes showing the maximum (make N) and minimum (make M).

Examining the results first for candle power, we find the value 14.5 as the average of all the lamps tested at the time the current was first turned on them. Of the 13 separate lots, six only show an initial candle power of 16 candles (neglecting tenths), though one make which started at below 15 rises above 16 within the first 100 hours. The lowest initial candle power is found for make M. Makes G, K and O start at 17 candles, the highest figure reached at the start.

Looking at the curve which gives the average percentage of initial candle power, Plate XIV., we find that the lamps on the average grow dim at a steady rate, falling off to 90 per cent. in about 200 hours, to 68 per cent. in 600 hours, and end at 1,200 hours with a little less than 55 per cent. Deferring the consideration of the C lamps, the M lamps sustain their power best, losing only about 6 per cent. in the first 300 hours, and ending a little under 70 per cent. of their initial candle power. The L lamps drop rapidly on the start, losing 30 per cent. in the first 300 hours and ending at 54 per cent. The E's and the O's drop to 47 per cent. at the close, but sustain themselves better than the L's in the earlier part of the run.

With respect to efficiency, using the term in its ordinary signification, as measured by watts per candle power (though in this sense the reciprocal is the proper measure), Plate XIV. shows an average initial value of 4.2, rising to 5.0 at 300 hours, 5.9 at 600 hours, 6.8 at 900 hours, and 7.0 at the end. The M lamps again have the best place, starting high but ending low, at six watts per candle power.



But what shall we say of the results as bearing on the question of the life of the lamp? The answer depends on what we shall define the life of a lamp to be.

Is a lamp alive as long as current will go through it? Some advertisers seem to think so, and they seem to have support in their opinion, for some of their patrons have sent them, with complimentary remarks, lamps through which current is said to have passed for 6,000 hours or more. Adopting this view, our test shows 96 out of 127 lamps decidedly alive at the end of an average of 1,120 hours, and the leveling of the average curves of Plate XIV. promises a considerable extension of their existence; 31 only have proven their mortality, and several of them lived to a good old age. The C's, poor things, all died young.

If we set the time of decease at the time when the lamp gives 50 per cent. of its initial candle power, as some claim, the lamps tested have passed 1,000 hours on the average, and certain makes have passed 1,200. If life be defined still with reference to percentage of initial candle power, but the limit be placed at 75 per cent., some individuals are still alive, but on the average, all died at 450 hours; 80 per cent. as limit cuts them off at 330 hours, and 90 per cent. at 180.

But there is yet another way of defining the life of a lamp. The one who ultimately pays for the lamp is the one whose premises are lighted by it, and the thing he is supposed to pay for is light. For him, the lamp is dead when it ceases to give a certain candle power, without reference to what its candle power was when it was new. His premises, let us suppose, are properly lighted by a certain number of new lamps which actually give 16 c. p. But when their light drops to 14 (12½ per cent.), he is no longer satisfied (and he ought not to be). For him the average lamp lasts about 249 hours. But if he is at liberty to choose the make of lamp, without reference to its efficiency, he will probably call for lamps of the G make, and get 400 hours service from them. If, however, he can induce the maker of the M lamp to make a lamp giving 16 c. p. when new, and having the same characteristics as those we tested, he will choose M's, and get 500 hours life. And that is the best that

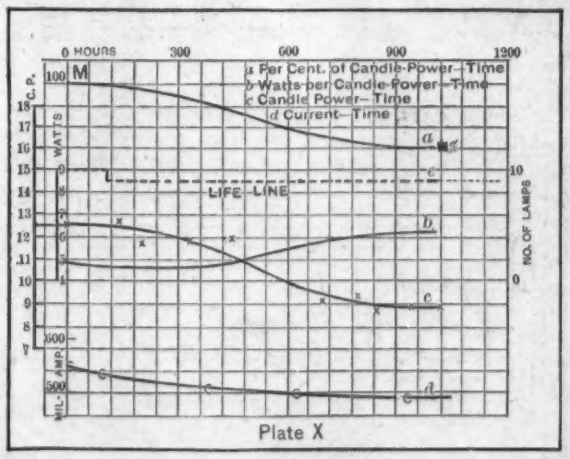


Plate X

can be done for him, so far as this test shows. He would not have B's, L's or M's, as at present made at all, because they do not give 14 c. p. when new, and if the station manager put in F's or N's he would order them out in less than a week. The state of things revealed by this test, as to the actual candle power of new lamps, is certainly not what it ought to be.

At the conclusion of the life test we dismounted all the lamps and placed them on a large table covered with clean drawing paper and uniformly lighted. The several lots were carefully examined with reference to blackening, the lot which was blackened the most being graded 100, and the other lots graded as closely as we could judge by comparison with the blackest lot and with one another. The grades are as follows: 10, 12½, 25, 28, 30, 32, 35, 42, 45, 50, 75 and 100 per cent. of the blackening of the blackest lot.

When the sorting and grading was satisfactorily completed, and the letters on the lamp bases examined, it was remarked that *the two lots which were least blackened were of the makes which are advertised as exhausted by mechanical pumps.* That they should both be so much alike in blackening, and both only one-half as much blackened as the least blackened of the mercurially exhausted lamps, is, to say the least, worthy of notice. It is, of course, not established that the observed freedom from blackening is due to the absence of mercury vapor in the lamps, as the makers claim, but if investigation should establish the claim the mercury pump will probably become once more a laboratory instrument. [The lot of lamps graded 10 per cent., and the lot graded 100 per cent., were mounted together on cardboard and exhibited.] As the giving of the letters designating the several lots of lamps, with the percentages of blackening, would, after the above statements, serve to identify the makers in the preceding tables and curves, the letters are omitted.

With regard to the performance of individual lamps of each lot, we found in some makes greater uniformity than in others, indicating either greater uniformity in manufacture or greater care in sorting the finished lamps on the part of some makers. The A lamps were among the best in this respect, and the C's and F's among the poorest. [Curves showing the individual performances of the lamps of the three lots named were here shown and discussed.]

So far as the lamps tested may be considered to fairly

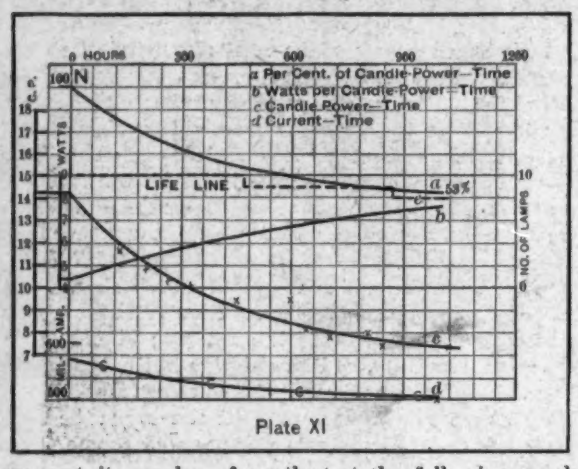


Plate XI

represent it, we draw from the test the following conclusions concerning the average 16 c. p., 110 volt, incandescent lamp:

First. The mean horizontal candle power of the lamp as defined is only 14.5 when new instead of 16 as labeled.

Second. The candle power of the lamp diminishes at a fairly uniform rate as it is burned, the rate of decrease being roughly 10 per cent. of the initial candle power for each 200 hours burned.

Third. The lamp makers' claim, that the lamp will burn for 600 hours before breaking, is more than established, 96 out of 127 lamps being unbroken at the end of over 1,100 hours.

Fourth. Defining the life of a lamp to be the number of hours it will burn before it will fall from 16 c. p. to 14, we find the life of lamps in all respects like those tested, but so made as to give an initial candle-power of 16, is 240 hours.

Fifth. The initial efficiency of the lamp is 4.2 watts per candle power. At 600 hours it is 5.9 watts and 1,200 hours 7 watts. The average efficiency during the first 600 hours is 5.04 watts.

Sixth. There is considerable difference in the rating of lamps by different makers, who nominally furnish the same article, the average initial candle powers of the several lots ranging from 12.5 to 17.0. There is also considerable difference in the uniformity of the product of different makers.

The above conclusions properly complete this paper, so far as the purpose for which the test was undertaken is conc rned. Some interesting points in the relative perform-

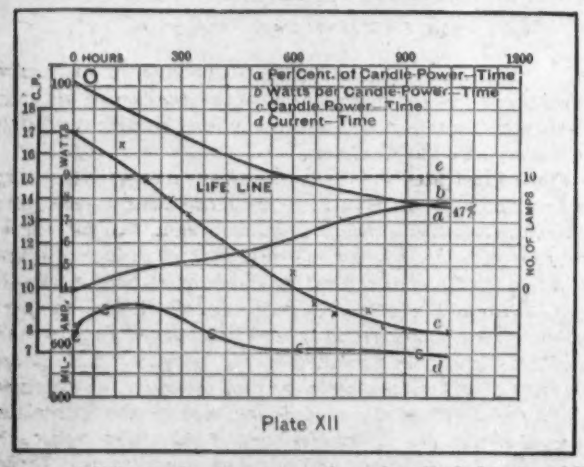


Plate XII

ances of different lamps may perhaps be alluded to in addition, since they cannot affect the makers.

Referring to Table V., lamps A, K, L and O have the same initial efficiency (3.9 watts per candle power), and for the first 700 hours A and L keep together, rising to 6.1 watts. K does better, rising only to 5.6 watts per candle power, while O rises to 6.9 watts. Referring to Table IV., there is greater difference among the makes named, the Ks at 700 hours giving 67 per cent. of their initial candle power, while the As give 61 per cent. and the Ls and Os only 55 per cent. Of the four makes therefore the Ks are best, since they maintain their candle power better and have the highest average efficiency. The differences, however, are so small as to make noteworthy the similarity between lamps of the

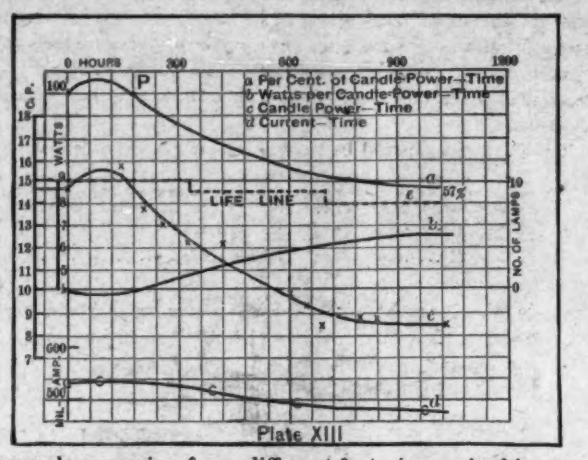


Plate XIII

same class, coming from different factories, as in this case. Comparing the Fs with the Gs in the same table, the Fs have a slight advantage in efficiency on the start, but they come together in 500 hours. The Gs, however, have such an advantage in the way they hold up in brilliancy as to balance the slight difference in efficiency and make them the better lamp.

The most interesting result, however, arises from a comparison of the lamps L and M. The Ls have the highest initial efficiency (3.8), and the Ms the lowest (4.8), excluding, of course, the Cs, which cannot be classed with good lamps, but after 250 hours burning the efficiencies are the same (4.75). At the start the Ls are furnishing light at the least cost but after 250 hours the Ms have the advantage in this respect. If we suppose both makes to be used for 700 hours, the average efficiency is the same for both. But at this time the Ms are giving 75 per cent. of their initial candle power, while the Ls are giving only 55 per cent. For the consumer the M lamp then is the better of the two, since the lighting of premises will be more uniform throughout the 700 hours of use supposed, and the cost of current for a given aggregate of candle power hours is no greater than with the Ls. If the time of use of the lamps be, say, 400 hours, the choice is not so evident, and will depend on whether the slight difference in cost (watt hours) is of greater or less importance than constancy of candle power of the lamps.

A rough graphic comparison between the several makes of lamps may be made by considering the areas between the curves *c* and *a* of the several plates. The curve *a*

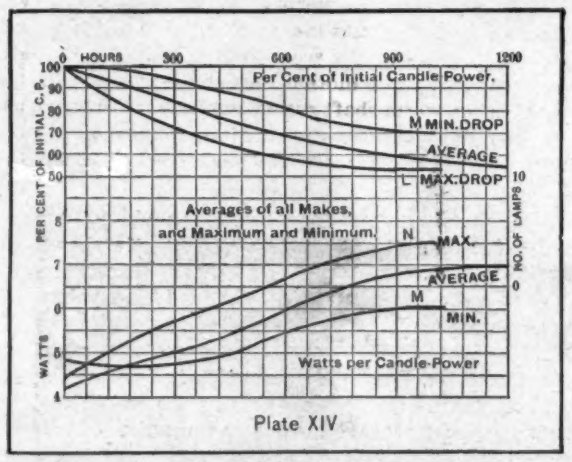


Plate XIV

is evidently parallel (raised three divisions) to the curve *c*, which would have been found if the initial candle power of each lamp had been 16 as labeled, other things being unchanged. The more nearly horizontal *a* and *b* are, and the lower *b* is, the better the lamp. As drawn, the curves can only give qualitative results by such comparison, but if the scale to which the *b* curves are drawn were properly chosen, the area comparison might give more accurate conclusions as to the relative merit of the several makes It is clear that the form of the area between the *a* and *b* curves in Plate X. is nearer the ideal than any other, and that of Plate XI. is poor. We are inclined to the belief that facts such as those alluded to in the comparison of the lamps L and M may lead to a modification of the views commonly expressed as to high and low efficiency lamps.

Long Distance Telephony.—II.*

BY HUGH NEILSON.

In connection with this matter of perfect working lines I may point out that long distance work success can only be attained by uninterrupted service from day to day. In telegraphy a message is handed to a clerk; the message may be transmitted immediately, or it may be delayed for a long time. The sender, however, does not know this. In telephony, the person wishing to converse has knowledge of all delays. If the line is broken or interrupted in any way, he is aware of it, and if he has tried two or three times in a day to be connected to a person in another town, and does not succeed, he very naturally loses faith in the telephone service. Any person giving a moment's thought to it can see that the very essence of successful long distance work is its reliability.

Equipment.—In Canada the ordinary Blake transmitter is used on all lines. A good metallic circuit is so silent that a Blake is quite powerful enough for any line we have up to three hundred miles. In the States the Long Distance Company's offices are equipped with what are known as "long distance" transmitters, a modification of the "Hunnings," but many subscribers to the exchanges use the "Blake" for all long distance work. To subscribers who can afford it, long distance cabinet sets are supplied at a rental running as high as $60 per annum in addition to the ordinary exchange rental. Booths, handsomely ornamented, can be purchased at prices varying from one hundred to two hundred and fifty dollars. Every part is double, *i. e.*, one box within another. When properly made and fitted such booths prove very satisfactory.

In the way of receivers, there is only one instrument to use Practically no change has been made in the construction of the "Bell" receiver since it was first sent out 14 years ago. It still remains the only instrument that will transform undulatory electric waves into sound waves audible to the human ear.

I can only glance at the remainder of the important points connected with equipment. The same care has to be taken inside the office—and in cables; devices for protection from electric light, lightning or other heavy currents, and in the central office switches—that is exercised outside. All instruments are bridged in, or, to put it plainer, are in multiple arc, as each side of a metallic circuit must be alike in every respect—conductivity, insulation and inductive capacity—or the line will not work perfectly.

Outside of North America the best line is that now working between London and Paris, the construction of which was complicated by the necessary cable across the channel, but all difficulties were overcome and the line works perfectly.

Rates.—In the United States the tariff is one cent per mile, with a minimum rate of 50 cents. Here it is just half that amount with a minimum of 25 cents. This applies to metallic circuits, but all circuits must soon be made metallic. so the foregoing may be considered as the settled rate. For short distances telephone users do not consider these rates too high, but when the distance is over 200 miles they cannot understand why the amount should be increased. Our almost universal tariff of 25 cents for telegraphing a message of 10 words has no doubt fostered this idea. The conditions, however, are entirely different, and telephone rates must be considered from the same standpoint as passenger or freight rates on a railway. A telegram going 12 miles, or 1,200 miles in Canada, costs the sender the same amount, but in telephoning, as in railroading, the rate must increase with the distance. To convey a telegraph message to any point only one wire is necessary. Between large cities this single wire becomes two by being duplexed, or four by being quadruplexed. To convey a conversation by telephone we need *two* wires, so that under any condition the capacity of a telegraph line must always be double that of a telephone line, and may have four or eight times the carrying power if required. Nothing of this kind can be done with a telephone circuit. There is no practical way of increasing the capacity. In addition to this great difference in actual carrying power, the conditions in telephony are such that the disparity is still further increased. Even when subscribers are waiting to speak, it is doubtful if more than six or eight conversations per hour can be put on any line, whereas a telegraph wire will easily carry three or four times that number of messages: or, keeping in view the fact that we need use two wires, it may be considered that the earning power of a telegraph wire exceeds a telephone line in the proportion of six or eight to one, and this is doubled or quadrupled if the telegraph wire is duplexed or quadruplexed. I need not point out also the great difference in the cost of construction. No. 13 hard drawn copper wire costs for metallic circuits say $80 per mile of poles, No. 9 iron wire, only $20. Long distance telephony has great possibilities before it. He would be a bold man who would consider that nothing more can be achieved. In my estimation the only difficulty is the commercial one. Next year we shall certainly see lines working from New York to Chicago, and how much further no one can tell. Canada can claim to be the home of the telephone. In the way of use by the general public, it may be said we lead. The villages, towns and cities of our country have more instruments in use in proportion to the population, and at a lower rental, than any other country, and I have no fear that we shall ever fall behind in this respect.

*A paper read at the first annual meeting of the Canadian Electrical Association.

Electrical Progress in Japan.

In a recent communication Mr. S. Katogi, of Tokio, Japan, gives some interesting information as to the extent of the various applications of electricity in Japan. The fact that the Tokio Electrical Society has 1,213 members shows that there is considerable interest in electrical matters there. The Nippon Electric Light Association was recently formed and held its first meeting on May 14. There are now 1,014 telegraph offices in the country. In Tokio alone the telephone subscribers number 1,000. A long distance telephone line between Tokio and Osaka, a distance of about 350 miles, was recently tried with very great success. Telephone exchanges will be opened at Kobe and Osaka at the end of the year. There are twelve electric light com-

panies in Japan at present. Two electric railway lines are under consideration, one of 12 miles and one of 17 miles in length.

A Brilliant Electric Sign.

On the corner block on Twenty-third street formed by the confluence of Broadway and Fifth avenue stands a small building, behind which rises an overtowering construction nine stories high, exposing a large surface 60 feet wide by 98 feet high. Upon the surface of this wall is erected perhaps the largest illuminated sign in the world, and certainly the largest and most conspicuous electrically illuminated sign.

In this sign, which is shown in the accompanying illustration, there are 107 letters, some six feet, some four feet, and some three feet high, each one of which is, in reality, a box of galvanized iron. In the interior of these boxes arranged in the outline of the letters are a number of small Edison porcelain series plug cut-outs, which are here used as lamp receptacles. At the lower end of each letter is a small sliding door giving access to a plug cut-out which serves to protect the lamps in that letter. Each letter is suspended and clasped top and bottom to two iron rods formed of strong steam piping which are securely attached to the wall by expansion bolts.

The illumination of the sign is obtained by the use of no less than 1,457 16-c. p. Edison lamps of different colors, white, frosted, red, blue and green. The current is taken from the mains of the Edison Electric Illuminating Company. There are seven sentences, each of which is on a separate circuit controlled by a lever switch. The switches are arranged temporarily on a rough wooden frame, and as the primary object of the sign is to keep the different sentences constantly appearing and vanishing, the operator is kept busy from dusk until eleven o'clock at night, when all the circuits are opened and the lights extinguished. The number of possible changes on these seven sentences is 5,040.

From the switchboard, along the roof of the smaller building, the line is led to the base of the wall, whence the different wires are led to their respective sentences. At the end of each line is a small platform and between each line a long rod of bicycle steel, each fastened securely to the wall, as are also the latter supports by expansion bolts. A flying ladder eight feet long, with small wheels, fits top and bottom to two of these rods and enables the attendant to run himself along each line and replace any broken or burnt out lamps or blown fuses, in a very few minutes. As an additional protection to the wires outside, they are run through conduit tubes thoroughly taped at their junctures, and are carried up the wall on porcelain insulators. The great difficulty with this sign, as is the case with all outside electric lighting work, lay in preventing the deleterious effects of rain and moisture. This has been overcome by fastening to the galvanized iron box letter covers over each hole, through which the lamps are thrust into the receptacles, small penthouses of iron which project out over the lamps, and carry off the rain, without interfering in any way with the effect of the sign. Any rain which might collect on the lamp surface is prevented from running down into the receptacle by a small projecting brass ring fastened to the outside of the lamp near to the shell. Each sentence is painted a different color, so that during the day the only thing lacking is the brilliancy of the illumination.

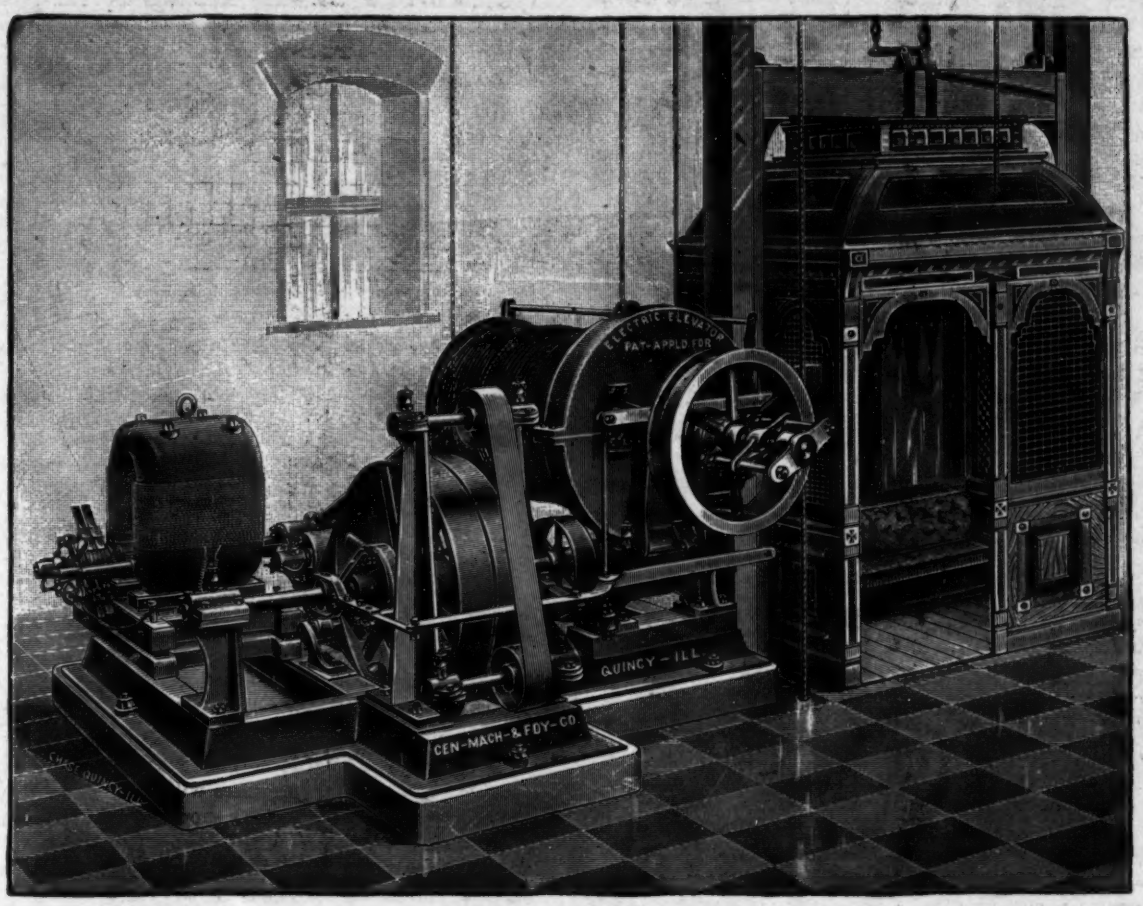
AN ELECTRIC SIGN.

The entire work on this was completed in about fifty days. It was designed by and constructed under the supervision of Mr. F. R. Upton, Mr. A. D. Page and Mr. McAllister, of the Lamp Works of the Edison General Electric Company.

An Improved Electric Elevator.

A new electric elevator recently brought out by the Central Machine and Foundry Company, of Chicago, is shown in the accompanying cut. It will be seen that the countershaft is discarded, and, while belts are used, the arrangement is such as to secure a very compact and at the same time a neatly designed machine. The motor and hoisting gear are all on the same frame, but the parts are easily accessible.

The drum is operated by worm gearing driven from two friction clutches. These clutches are connected with two pulleys on the worm shaft, and these pulleys are in turn driven by two belts from a double pulley on the end of the armature shaft. One of the belts passes directly around one of the pulleys on the worm shaft, and the other over two idlers, in such a position that the back of this belt comes in contact with the second pulley on the worm shaft, thus giving a reverse motion. By this arrangement the pulleys on the worm shaft run in opposite directions from each other, while the armature shaft continues in the same direction. A hand cable or shifting rope passes up the elevator well, and is connected with a sheave on the extended drum shaft, which sheave is connected by levers to the clutches. By operating this cable either clutch can be thrown in or both left out, thereby starting, stopping or reversing the elevator.



ELECTRIC ELEVATOR.

Starting with a full load consumes a large amount of current and necessitates the use of an unusually large motor for the work, as in the case of street car service. When a motor runs continually its own momentum assists materially in starting the load, and in this form of machine the two pulleys on the worm shaft act as fly wheels.

There is also an efficient slack cable stop which immediately stops the hoisting gear in case the car or platform is arrested in its descent.

Two plates acting as levers are provided, one on each side of the car or platform, and on each of these plates are fastened two jaws in such a position that they can be opened or closed, thereby griping the car to the guide strips or releasing it as may be required. These jaws are connected with the hoisting cable or cables by levers in such a way as to secure the release of the jaws as long as the cable sustains the load.

Should one cable give way the other or others will act upon a safety catch and cause it to grip the guide strips securely. The jaws are not operated by a screw, but by a simple lever equally effective.

Any style or make of motor can easily be used in connection with this hoisting gear.

The Fulmen Arrester.

For complete metallic circuits, well insulated from earth, or for circuits normally carrying very low potential currents of electricity, there is probably no better nor simpler lightning arrester than a pair of discharge plates separated by a small air gap, and connected, the one to line and the other to ground. With longer circuits, of uncertain insulation and increased potential, a new arrester became a necessity, but not until the ground return circuit came into general use for electric power transmission did the matter of providing an indestructible arrester appear so formidable.

Believing the simpler method to be the better, a line of experiments has been conducted with a view to adapting the oldest and simplest arrester to street railway circuits, and naturally these begin with a pair of carbon discharges and a fuse in series.

In the original form one pair of discharges did service for many fuses, but each discharge decomposed more or

FIG. 1.—THE FULMEN ARRESTER.

less of the carbon, rendering it less effective for successive discharges. In the improved form the discharges act but once, and, consequently, are in the best possible condition for that particular discharge.

Fig. 1 illustrates the new "Fulmen" arrester, consisting of two fine brass wires, which are hermetically sealed into a small glass tube, so that their inner ends lap for three-quarters of an inch, with one-twentieth of an inch of space between them. These form the dischargers, which are always clean and bright. Ten fuses are attached to the porcelain cover of the arrester box by soft rubber plugs, which fit tightly into holes provided for the purpose. The plugs are kept in adjustment by knots near the outer extremities of the fuse. When the cover is attached to the porcelain box, shown in Fig. 2, the free ends of the fuses approach the terminals of the line and ground connections. These latter consist of carbon rods and are located in vertical channels in the porcelain box. The ends of the upper fuse are connected respectively to line and ground, by small carbon wedges, which rest on their extremities and continually bear against the carbon rods.

In this position the arrester is ready for action, and offers a free passage to earth for an atmospheric discharge, except for one-twentieth of an inch of space between the dischargers. A lightning discharge will bridge this span

starting an arc which will short-circuit the dynamo current at that point, and the consequent rush of current is sufficient to entirely consume the fuse and allow the carbon wedges to drop and connect fuse number two.

The remaining fuses are protected from the heat of the arc of any one by the deep corrugations of the porcelain

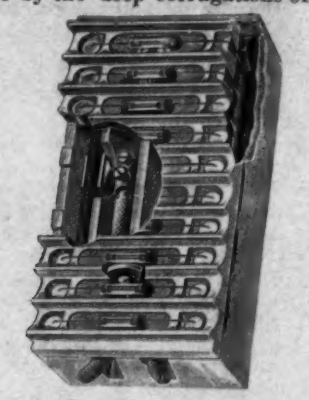


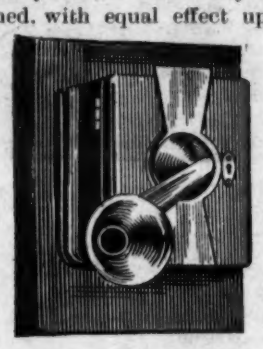
Fig. 2.—The Fulmen Arrester.

cover. Proper grooves and ventilation prevent short circuits in the porcelain box, rendering the apparatus certain to act for 10 discharges, which is considered sufficient for one locality during one storm, after which the arresters should be inspected and the vacant spaces filled with new fuses, allowing the carbon wedges to rest on the top fuse as before.

These arresters are applicable to cars, pole line or station, and measure 8 × 4½ × 2½ inches. They are put upon the market by C. S. Van Nuis, 136 Liberty street, New York.

The Marcus Auxiliary Mouthpiece.

A useful adjunct to the telephone, in the form of an auxiliary mouthpiece, has been invented by William N. Marcus, of Philadelphia. It is only necessary to talk in the usual tone of voice in front or at either side of the mouthpiece, and the sound is carried directly to the diaphragm of the telephone, so that every word is distinctly heard, it is claimed, with equal effect upon long or short



The Marcus Telephone Mouthpiece.

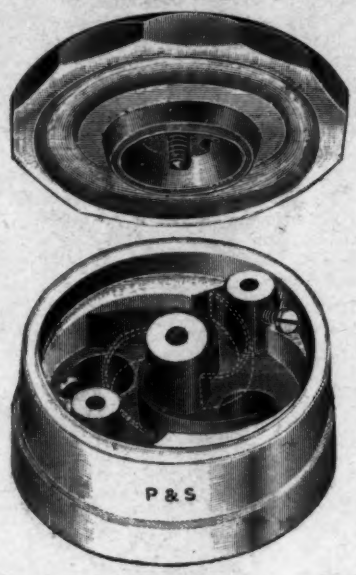
distance telephones. The mouthpiece, which is shown in the accompanying illustration, is easily attached or removed without injuring the telephone in any way, is always readily adjusted for use by the tallest or shortest person. It is so simple in construction that it will hold its efficiency for years, and is got up in an ornamental form. William C. Tripler, Jr., 218 North Second street, Philadelphia, has charge of the manufacture of this device.

The Wing Fan and Diehl Motor.

The accompanying cut shows a Wing disc fan driven by a Diehl motor brought out by L. J. Wing & Co., 126 Liberty street, New York. This forms a very compact and reliable combination. The fan is simple in construction and very effective. The novelty of the machine is that the motor is connected directly to the fan without intermediate speed reduction. The Diehl motor varies from the ordinary type in the construction of the field magnets and armatures, the armature revolving around the field magnets instead of between them, as is ordinarily the case. The motor is compact in form, and is particularly adapted or di rect attachment in cases were slow speed is required.

Pass & Seymour Single-Pole Switch.

The accompanying illustration shows a very simple type of single pole switch. The switch is made entirely of china, and it is constructed in such a way that the china cover operates the switch, and there is no key or handle projecting above the top. The switch is small and very neat in appearance. It is of the type which gives an absolutely quick double make-and-break with rubbing contacts, and a break sufficiently long to prevent the drawing



Pass & Seymour Switch.

of an arc. The finished switch is decorated in various styles to correspond with different styles of interior decoration.

The Detroit Electrical Works' New Dynamo.

The type of generator illustrated in the accompanying cut is that which has been adopted by the Detroit Electrical Works for all sizes, up to and including the 30 kilowatt machine. The dynamo is a two-pole machine, in which the frame and the plate consist of one solid casting. In designing this machine the advantages of slow speed have been kept in view as well as the efficiency, and, as a result, they have a slower speed than any other machine of equal capacity, it is claimed, while their efficiency compares favorably with that of any.

The general design is such that the armature is protected on all sides by the frame of the machine and the metal flanges of the field spool. All these generators are compound wound, to give any desired increase to the voltage up to 15 per cent. at full load. The armature of the machines up to the 30 kilowatt are of the drum type, but a special winding is used which economizes space and gives the greatest opportunity for ventilation. The field coils are wound on metal spools and then slipped into place on the pole pieces.

Carbon brushes are used on all sizes of the machines with a special form of brush holder, in which the tension is obtained by the use of a spring coiled in the form of an involute, the outer end of which is continued straight over the side of the coil, which is below the brush holder, up to and a little above the outer ends of the carbon brushes.

These dynamos are designed for a fixed point of commutation which renders possible the reversing of the machine, and changing from no load to full load without appreciable sparking. The standard sizes of this new type rated in kilowatts are ½, ¾, 1½, 3, 5, 7½, 9, 15, 20, 30, 40, 60 and 100.

The Billings Wire Cutter and Pipe Wrench.

Two new devices, a wire cutter and a pipe wrench, which have lately been brought out by the Billings & Spencer Company, of Hartford, Conn., are shown in the accompanying illustrations. The wire cutter is seen in Fig. 1, and

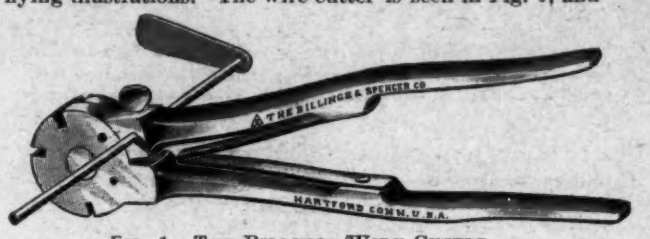


Fig. 1.—The Billings Wire Cutter.

will be appreciated by those who have to handle electric wires. Its sphere of usefulness can be readily seen from the cut. It is drop-forged from the best tool steel and provided with four cutting edges on the rim and two which are inclosed. It also has an adjustable gauge, so that wire can be cut accurately to any length. Its total length is 10 inches.

Fig. 2 represents the pipe wrench. The jaws are drop-forged of the best tool steel and the handles of the best grade of machinery steel. This wrench is simple in design, has few parts, and has the special feature that no matter how large or small the pipe for which it is adjusted,

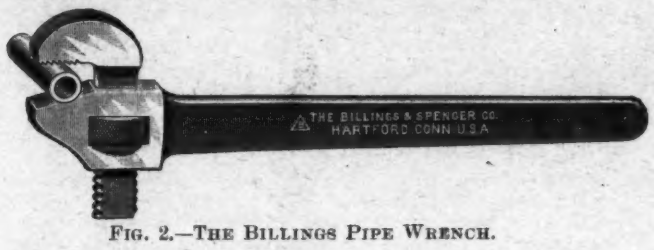


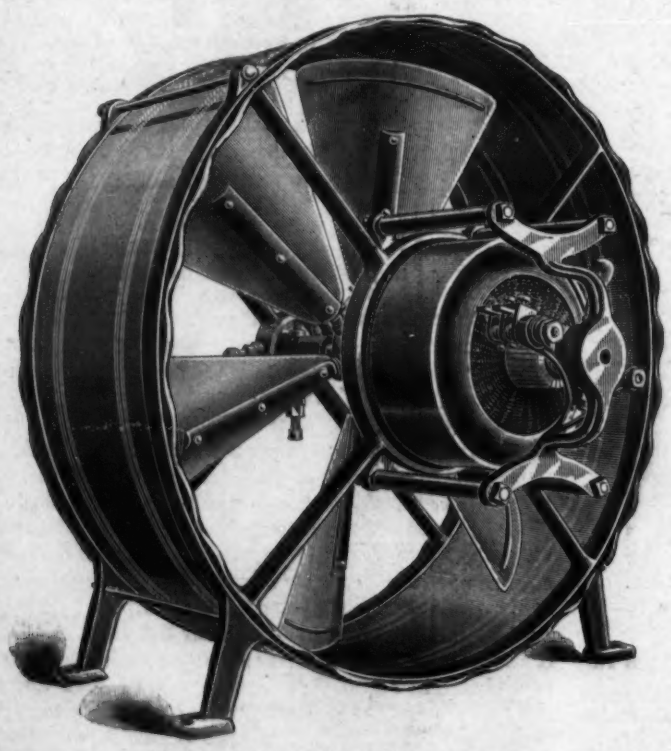
Fig. 2.—The Billings Pipe Wrench.

the angle of the jaws always remains the same. The length is 14 inches, and it is made to take pipe one-quarter to one and a half inches in diameter.

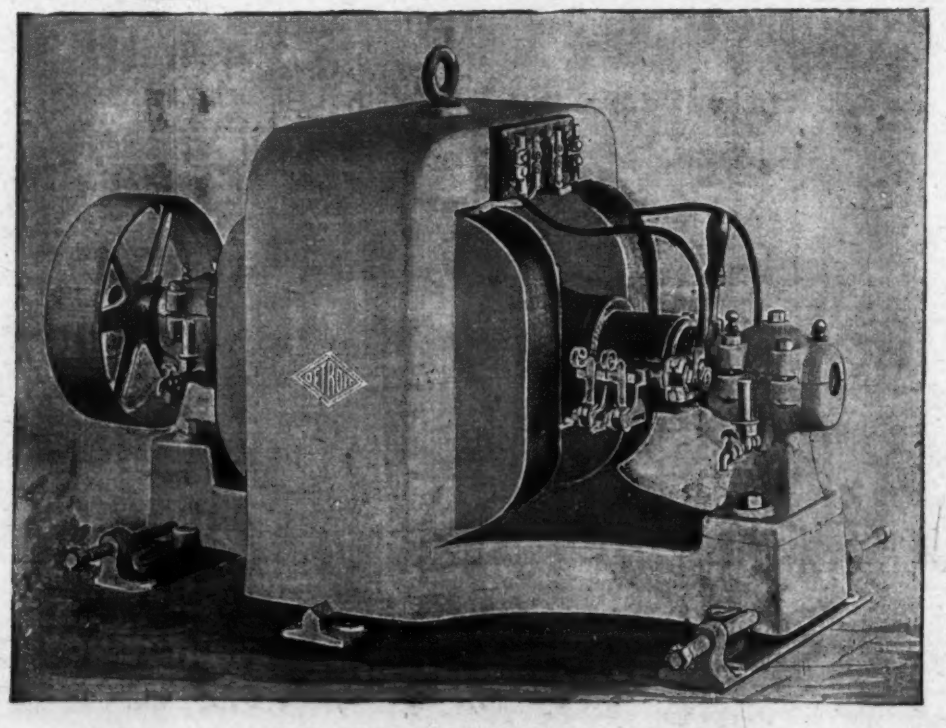
Useful Applications of Electricity.

"In a measure akin to the use of electricity in furthering chemical operations are the recently reported experiments on passing currents through the soil in which plants are growing," says Professor Elihu Thomson in the July *New England Magazine*. "The reported results are that plants so treated developed much more rapidly than others similarly placed, but which did not receive the effect of current. Future tests will undoubtedly be made on this important subject, and should the results be confirmed and prove to be economically obtained, the outcome may be the establishment of electrical farms, and we may yet partake of early electrical vegetables, even if we do not find *pomme de terre a la dynamo* or *asperges electriques* on our bill of fare.

"If electricity may be found useful in favoring the growth of plants under suitable conditions, may it not also be found suitable in limiting the number of insect pests! Now we can make a netting of a warp of fine metal wires and a weft of silk threads, arranging it so that every alternate wire is respectively connected to the positive and negative pole of a small induction coil capable of giving a small spark and yet of insufficient force to pass from wire to wire in the fabric. It is safe to say that an insect, such as a fly or mosquito, landing on such a surface, would receive his quietus, or be electrocuted strictly in accordance with New York methods."



WING FAN AND DIEHL MOTOR.



THE DETROIT MOTOR AND DYNAMO.

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK AND BOSTON, July 9, 1892.

New York General Financial Review.—The present has been an off week in lethargic Wall street. The Fourth of July had a tendency to break up the usual forces of the market. The passage of the free coinage Silver bill by the United States Senate on Saturday acted with a decidedly depressing effect upon values of almost the entire list. The active stocks scored an average decline of 1½ per cent. Added to this was the announcement of a reduction of $1 per ton in pig iron—the barometer of the industries of the country—and the serious aspect of the Homestead iron riots. Besides this, news of freight rate cutting in the West, the bad corn crop reports, and the destruction of the mid-summer tourist business because of the one fare rate which has prevailed from all Western points to New York, Boston and Montreal, because of the National Christian Endeavor and Pharmaceutical conventions. A little later in the week fears of the passage of the Silver bill gradually wore off on assurances that if passed by the House it would meet a presidential veto. This stopped London selling in a measure, and partially restored confidence in this market. About $1,400,000 gold went out this week, against $3,709,800 last week and $44,937,300 during the year. This would seem to indicate that the gold movement will be stopped for a time at least. Money on call was easy at 1½ to 2 per cent; time loans 3 per cent. 60 days, 4 per cent three months, 4½ per cent. four months.

New York Electrical Stock Market Review.—This market has been influenced by the general conditions which have been mentioned preceding, and which to an extent have destroyed all activity except in half a dozen active stocks in the accompanying list. Western Union was among the first to suffer a decline upon the opening Tuesday, from the closing of 94⅛ last week, and went as low as 92¼. Support from insiders carried it up to 93¼, at which point it closed to-day. Movement of the stock during the week would seem to indicate that there is a very small short interest, that the principal owners of the stock are evidently anxious to place it at par. General Electric during the fourth week of its Stock Exchange career was, comparatively speaking, very active, although at the expense of values. It sold as high as 108¼ last week, from which figure, under heavy pressure to realize on part of certain holders in the face of no market, it sold off reaching 105 on Thursday. During the latter days of the week it rallied slightly, closing at 106¾ to 107. More stock changed hands than has been dealt in since it has been listed. It is looked upon as having an intrinsic value of between 110 and 111, and will probably go to those figures on the first rally of the market. American Telegraph & Cable was in some request, selling during the first part of the week at 84¾ to 85½ and later at 86. North American showed slightly increased values upon comparatively slight transactions. Commercial Cable was not traded in during the week, but was several times bid 154 and steadily held at 156½, and two sales of Western Union bonds are worthy of note; 10,000 shares of debentures, 7s, 75 registered, went at 116½; 2,000 shares of collateral trust 6s at 104, and 1,000 shares of collateral trusts 5s at 104.

Boston General Market.—The professional bears were not slow to improve their opportunities for raiding the market offered by the scare of silver legislation and the violent outbreaks in the iron and steel districts, but their success was very short lived, and stronger forces have more than counterbalanced their onslaught. The week's market closed with a much stronger feeling all around but still quiet. The silver question is now shelved; and if the gold exports, which are already growing less each week, will stop altogether the market must at once respond to the particularly favorable conditions which prevail throughout the country. The money market is in a good condition. Rates are better than they have been for months, and the era of 2 and 3 per cent. money has passed. Loans have been comparatively few during the week, since the lenders are demanding better rates than parties are at once ready to meet. European markets have been realizing on our securities to a certain extent; not sufficiently, however, to depress our prices, but the movement shows that, in a word, Europe is poor. The tide turned slightly at the end of the week, however, and good buying orders came over from London.

Electric Stocks in Boston.—It has been a rather quiet week for electrics in Boston, and prices show a slight fall from last week's quotations. The principal sales have been in Thomson-Houston, which under small sales lost a point, but regained it all later in the week with its usual good strength. The preferred has remained at old prices with very few sales. General Electric sold on Thursday for the first time, opening at 106 for the common and 117 to 119 for the preferred stock. This is a most favorable start for the new stock on such a market as the present one, and only shows how the electrics keep out of the narrow rut of fluctuation. Westinghouse lost over a point and sold down to 27, but later returned to 28. A little selling might materially depress this stock, but in the absence of trading the strength behind it and reports of the business seem sufficient to keep it up to its usual price. The announcement of the common stock dividend of two dollars on Northwest Thomson-Houston stock creates still better strength in that stock, and it is held very closely. The telephone stocks are fractionally lower, simply from the usual dullness of the summer market. Bell has lost five points within a week from 209 to 204. The continued increase of earnings from summer business has no apparent effect on West End railway stocks. The preferred maintains its price of 88 to 89, but the common is two points lower even than the auction sales of some weeks ago. Detroit electric stock has been selling lately at 7, with some further demand for it at that price, but very little stock comes out, as it was nearly all bought at a much higher figure. Par would look much more reasonable for the stock than the present price.

The Industrial Improvement Company.—It is understood that the dividend of 50 per cent. declared by this company, payable July 1, will be paid in new capital stock. The present capital is $500,000, and it is proposed to double it by capitalizing $520,000 of surplus. This company has been in operation about two years, on a paid up capital of $400,000. May 1 it had earned $270,000 net, including security assets. The company was formed to promote electrical construction and reconstruction in the interest of the Thomson-Houston Electric Company. It bought and reconstructed a railway between Allentown and Bethlehem, Pa., also the Brockton and East Side and Whitman roads, also a road from Haverhill to Lawrence, Mass. It acquired the Atlanta (Ga.) lines, but turned them over to the Thomson-Houston Company for a stock consideration and some $17,000 in dividends.

The Westinghouse Electric and Manufacturing Company have brought suit against the Duquesne Traction Company and another Pittsburgh traction company for infringing the Finney patent on the overhead trolley system. The papers in the suit were filed late last week. The shipments from the Westinghouse works during June exceeded those for any month in its career, the horse power of the motors and generators shipped reaching nearly 10,000. Work has already been started on the alteration of the air brake property in Allegheny to provide for the manufacture of large generators for railway work and for the World's Fair lighting. At the branch works at Newark the manufacture of street railway motors has already been begun, and the capacity will be raised to an output of 10 motors daily, besides generators and other details, making the total capacity of the company on street railway motors between 140 and 150 per week.

Increase in Capital Stock.—The Rockland (Mass.) & Abington Electric Light and Power Company has increased its capital stock. The estimated earnings of the company for the fiscal year are $16,000, and operating expenses $9,000. The Edison Electric Light and Power Company, of Kansas City, Mo., has increased its capital stock from $150,000 to $225,000. The American Illuminating Company of Hornellsville, N. Y., has certified to an increase in capital stock from $50,000 to $65,000. The Charleston (S. C.) Light and Power Company has increased its capital stock from $50,000 to $100,000. The Lebanon, Mo., Light and Water Company has increased its capital stock from $100,000 to $250,000.

Dividends.—The Lyons (N. Y.) Electric Light Company is paying a semi-annual dividend of 3 per cent. The Northwest Thomson-Houston Electric Company has declared a dividend of 2 per cent, payable July 15. The Detroit Electrical Works' dividend of 2 per cent. is payable July 15.

The Copper Market.—The copper market has not changed since our last report, except perhaps in the attitude of the companies, who are said to be asking 11¾ against 12 cents formerly. There is quite a heavy tonnage moving on contracts held by manufacturers of electrical goods. These will expire at the end of this month, and will probably be renewed at the same figure. The copper combination, so called, is pronounced by all to be a complete failure. Exports of copper matte aggregated 831,000 lbs. No pure copper was sent out.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, July 9, 1892, in New York, Boston and Chicago.

NEW YORK QUOTATIONS.

	Par.	Capital outstanding.	Lowest.	Highest.	Bid.	Ask'd.
American Bell Tel	100	17,500,000	....	....	....	..
Debentures subject to call at 100	...	2,000,000	...	....	....	..
American District Tel	100	3,825,000	...	....	60	62
American Tel. & Cable	100	14,000,000	84¾	86	85	86½
Central & So. Am. Tel	100	6,000,000	....	....	..	..
Commercial Cables	100	7,716,000	....	....	154	156½
Debentures	...	1,000,000	....	....	....	..
Erie Tel. & Telp	100	4,800,000	....	....	..	..
Gold Stock & Tel	100	5,000,000	..	....	100	103
Bonds	500	500,000	....	....	100	..
Mexican Tel	100	2,000,000	....	....	....	..
Northwestern Tel	50	2,500,000	....	....	....	..
First Mort. Sinking Fund	500	1,180,000	....	....	....	..
Postal Tel. & Cable	...	10,000,000	....	....	62	64
Southern & Atlantic Tel	25	948,775	....	....	78	84
Western Union Tel	100	15,000,000	....	....	92¾	93¼
Real estate bonds	1,000	1,219,000	....	....	....	..
Debenture bonds	1,000	1,920,000	....	....	....	..
" sinking fund bonds	500	841,266	....	....	....	..
Collateral Trust 5's	1,000	8,181,000	..	106	....	..
North American	100	39,767,200	13½	13¾	....	....
Brush Ill. Co. of N. Y	50	1,000,000	....	....	30	60
Edison El. Il. of N. Y., exright	100	6,500,000	....	....	84	85¼
Edison El. Il. of Brooklyn	100	750,000	...	....	85	90
" " " Chicago	100	750,000	....	....	130	145
" " " Boston	...	.....	....	....	115	125
Edison El. Lt. Europe	1,000	2,000,000	....	....	2	6
" Bonds	...	30,000	....	..	65	80
Edison Ore Milling Co	...	2,000,000	....	....	15	20
East River El Light	100	1,000,000	....	....	....	65
General Electric	1,000	50,000,000	....	....	104½	107½
Automatic Exhibition Co.	...	2,500,000	..	....	3	5
Mt. Morris Electric	...	500,000	....	....	....	65
N. E. Phonograph	..	2,000,000	....	....	2	4
N. Y. Phonograph	...	2,000,000	....	....	2	5
North American Phonograph	...	2,000,000	....	....	4	6
Westinghouse Elec & Mfg. Co. 1st p. 7 per cent. Cum.	50	3,717,253	....	...	....	....
E. & M. Co. Assg	50	5,038,116	....	....	....	..

BOSTON QUOTATIONS.

	Par.	Capitalization.	Highest.	Lowest.	Bid.	Ask'd.
Thomson-Houston Elec	25	6,000,000	64¾	63⅝	64	64½
Thomson Houston Elec. preferred	25	4,000,000	30	29½	29¼	29¾
Thomson-Houston Elec.—Series C	sh	40,000	....	....	8	9
Thomson-Houston Elec.—Series D	sh	120,000	7¾	7⅛	7⅛	7¼
Thomson-Houston Int'n'al Elec	100	600,000	....	....	250	260
Thomson-Houston Int'n'al Elec—Pfd	100	400,000	....	....	103	106
Thomson Elec. Weld	100	1,000,000	....	....	45	45
Thomson European Elec. Weld	100	1,500,000	....	10	....	12
Westinghouse Elec.—New Com.	..	6,000,000	28¼	27¼	27	28
Westinghouse Elec.—Pfd.	..	4,000,000	....	....	44	45
Fort Wayne Elec	25	4,000,000	12⅝	12¼	12⅝	12⅝
Fort Wayne Elec.—Ser. A.	sh	80,000	7½	7⅝	7¼	7⅛
Detroit Elec	10	1,000,000	....	....	*6½	7
West End St. Ry. Co.—Com	50	7,150,000	73¾	71⅝	72½	72½
West End St. Ry. Co.—Pfd	50	6,400,000	88	...	87¾	88
American Bell Tel	100	15,000,000	204½	201½	203	204
Erie Tel. & Tel. Co	..	4,800,000	45	44¼	44¼	45
Mexican Tel. Co.	10	1,280,000	1.05	....	1.02½	1 05
New Eng. Tel. & Tel. Co.	..	10,304,600	56	55	55	56
Tropical Tel. Co	10	400,000	....	....	....	....

*Ex-dividend.

CHICAGO QUOTATIONS.

Following are the quotations of telephone and electric stock furnished THE ELECTRICAL WORLD by C. V. Banta, Jr., 167 Dearborn street:

Telephone Stocks:	Bid.	Ask'd.	Electrical Stocks:	Bid.	Ask'd.
Chicago	223	..	Chicago Arc Light & Power Co	92½	95
Central Union	56½	..	Chicago Edison Co.	160	..
Great Southern	..	30			
Iowa Union	20	25			
Michigan	88	92			
Wisconsin	..	130			
Missouri & Kansas	..	58			

NEW INCORPORATIONS.

The Western Light and Heat Company, of Chicago, Ill., capital stock $25,000, has been formed. The incorporators are Wm. J. Sanborn, J. DeWitt Krebs and Frank A. Helmer.

The Columbus Mining Company, of Richmond, Va., capital stock $53,000, has been started to erect electric light works, etc. M. M. Child, W. J. Fell, R. W. Traylor, A. J. Pleasants and E. H. White are the promoters.

The Valley Light and Water Company, of Sumner, Wash., capital stock $50,000, has been organized to erect and maintain electric light plants, etc. George H. Ryan, P. D. Rice and George Herriott are the promoters.

The Delta Electric Company, of Cairo, Ill., capital stock $150,000, has been formed to operate electric light, heat and power plants, railways, etc. The incorporators are Henry Hasenjaeger, William Kluge and Harris Schulze.

The San Francisco Electrical Storage Company, of San Francisco, Cal., has been incorporated with a capital stock of $1,000,000. The directors are D. Gilbert Dexter, C. B. Sessions, S. C. Mills, H. W. Spalding and E. J. McCutcheon.

The Hartford Electric Light and Power Company, of Hartford, Vt., capital stock $12,000, has been organized to manufacture light and power. Allen L. Pease, Jos. F. Whiting and Alfred E. Watson, of Hartford, Vt., are the incorporators.

The North American Gas Company, of Chicago, Ill., capital stock $500,000, has been formed to manufacture and supply electricity for light, heat and power, etc. Charles M. Hill, John D. Cameron and James R. D. Graham are the promoters.

The Northern Light Company, of Chicago, Ill., capital stock $100,000, has been formed to operate an electric light and power plant and all machinery necessary for the same, etc. W. H. Hutchinson, Lewis Lusk and A. C. Barnes are the incorporators.

The Pontiac Water, Light and Power Company, of Chicago, Ill., has been incorporated with a capital stock of $60,000, to build, operate and lease water, gas and electric light works. J. J. Hainsworth, W. G. Reeve and H. Ream are the incorporators.

The Bristol Electric Company, of Rutland, Vt., capital stock $15,000, has been formed to furnish heat, light and power and to carry on business connected therewith. Rockwood Barrett, Edward Dana and Horace N. Dyer, of Rutland, Vt., are the incorporators.

The Port Gardner, Lake Stevens & Eastern Railway Company, of Everett, Wash., capital stock $250,000, has been formed to build, own and operate electric light plants, telephone and telegraph lines, etc. John F. Hart and J. M. Davis, of Tacoma, Wash., are the promoters.

Claflin & Kimball, Incorporated, of 116 Bedford street, Boston, Mass., capital stock $135,000. This company is to manufacture and sell dynamos, batteries, arc and incandescent lights, etc. Adam D. Claflin, Marcus M. Kimball and George Walker, all of Boston, are the incorporators.

The Ashland Lighting and Street Railway Company, of Ashland, Wis., capital stock $200,000, has been formed to operate and maintain an electric lighting plant and electric railway. The organizers are Thomas Barton, G. W. Harrison, G. H. Hopper, S. S. Fifield and John H. Knight.

The Queen City Electric Railway Company, of Marion, Ind., capital stock $180,000, has been formed to construct, own, maintain and operate by means of electricity or other motive power street railways in Marion. Aretus W. Hatch, James D. Devor and Willard C. Nichols are the incorporators.

The Morningside & Highland Park Railway Company, of Pittsburgh, Pa., has been formed, with a capital stock of $35,000, to construct and operate an electric railway in Pittsburgh. Henry A. Davis, Chas. E. Cornelius, of Sewickley, Pa., and Wilkins Linhart, of Allegheny, Pa., are the incorporators.

The Immisch Electric Navigation and Power Company, of Hoboken, N. J., capital stock $250,000, has been formed to manufacture machines for the production of electricity, etc. A. Schwarz, A. Benecke, Newark, N. J.; V. D. Walsh, O. Goerz, New York and T. Aub, of Hoboken, N. J., are the promoters.

The Gray International Telautograph Company, of Chicago, Ill., with a capital stock of $1,000,000, has been formed to buy, sell, own and operate electrical appliances, patents and privileges in foreign countries. Frederick W. Cushing, Horace A. Cushing and James W. Chisholm are the incorporators.

The Denison Electrical Manufacturing Company, of Portland, Me., capital stock $500,000, has been formed to manufacture and deal in articles composed of mineral and vegetable substances. The incorporators are C. D. Wainright, W. M. Thayer, Boston, Mass., and Russell A. Denison, Providence, R. I.

The New Kensington Traction Company, of New Kensington, Pa., capital stock $2,000, has been organized to construct and operate motors, cables, or other machinery for supplying motor power to passenger railways, etc. S. E. Moore, James P. Anderson and Howard Childs, of Pittsburgh, Pa., are the promoters.

The Hollidaysburg Electric Light and Power Company, of Hollidaysburg, Pa., capital stock $23,000, has been formed to supply light, heat and power to the citizens of Hollidaysburg and Gaysport, Pa. The organizers are F. H. Russ, of that town, and W. F. Taylor and A. J. Anderson, of Altoona, Pa.

The Elevated Suspension Railway Company, of Chicago, Ill., with a capital stock of $4,000,000, has been formed to operate and build electric elevated suspension and dummy railways under patents issued to Lysander Johnston, Raleigh Clapp, etc. Lysander Johnston, Gustave L. Ladd and Henry A. Buell are the incorporators.

The Waitsburg Light and Power Company, of Waitsburg, Wash., capital stock $25,000, has been formed to generate electricity for light, heat and power, and to erect and operate telegraph and telephone lines, street railways, etc. Geo H. R. Preble, John C. Onderdonk, Spokane, Wash.; J. H. Morrow, P. A. Preston, Waitsburg, and J. R. McKinley, New Whatcom, Wash., are the promoters.

AFFAIRS OF THE COMPANIES.

The Edison Electric Light and Power Company, of Kansas City, Mo., has decided to increase the capital stock from $150,000 to $225,000.

The Fort Wayne Electrical Company is considering the establishment of a branch plant in Jackson, Mich., for the manufacture of electrical machinery.

The Geneva Brush Electric Light and Power Company will make extensions to the value of $70,000 in its plant with a view to an increase in electric lighting service and an electric street railway system.

The Electric Light Company, of Iowa Falls, Ia., has elected the following officers: President, E. S. Ellsworth; vice-president, W. H. Courtney; secretary, H. C. Miller; treasurer, W. H. Woods. The work on the plant will begin at once.

Normal, Ill.—An electric light company has been formed with John Cook as president, R. R. Reeder vice-president, David Felmley secretary, and John Aldrich treasurer. The plant will be erected by a Peoria firm, and the power house will be a one-story brick building 45 × 30 feet.

The Atlantic City Electric Lighting Company at its annual meeting of stockholders elected the following directors: A. G. Cattell, E. A. Armstrong, Wm. S. Scull, G. G. Browning, Benj. G. Felton, J. A. Bodine, Lewis Evans, Elias Wright, Peter B. Risley, John J. Burleigh, J. Willard Morgan, David Baird and B. C. Reeve.

The Columbus Street Railway Company, of Columbus, O., has effected a permanent organization with the following officers: E. E. Denniston, president; E. K. Stewart, first vice-president and general manager; R. E. Sheldon, second vice-president; Emerson McMillin, B. J. Burke, G. W. Sinks, C. D. Firestone, P. H. Bruck and Theodore Rhoades, directors.

The United States Wire and Cable Company has been formed to manufacture and sell wire, wire ropes, cables, etc; to make and sell machinery, and the insulation and covering of wires and cables. It will locate at Schenectady. The directors are: Benjamin E. Sunny, Chicago; Silas A. Barton, Boston; Samuel Insull, S. Dana Greene, New York; John Krousi, Schenectady.

Mr. C. M. Coen, of Hyattsville, Md., will organize a company at Hyattsville for the purpose of erecting in that town an electric light plant, coal storage, ice plant and water works. Mr. Coen has had large experience in this line and is at the present time treasurer and managing director of the Racinite Fireproofing Company, of Washington, D. C., and president of the Harlem Associated Heirs Title Company.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-176 Times Building, New York, July 12, 1892.

Cyrus W. Field died this morning at his country residence, Ardsley, near Dobbs' Ferry, aged 73 years.

Henry A. Cleverly, of Philadelphia, favored New York with a visit last week during the annual meeting of the Society of Christian Endeavor.

New York.—The Morrisania & Fordham Railway, the Melrose & West Morrisania Railroad Company, and the North Third Avenue & Fleetwood Park Railway Company are to be consolidated. The new organization will be known as the Union Railroad Company, and will be operated under the trolley system. The bill authorizing a consolidation and the use of the trolley system was passed by the present legislature.

The Tunnel Plan Approved.—The General Term of the Supreme Court has handed down a decision confirming the report of the Special Commission appointed to hear arguments for and against the plans proposed by the Rapid Transit Commission. The report favors the building of the tunnel under Broadway, and the decision allows the work as originally planned to proceed. About ten days ago the Commissioners appointed by the Supreme Court to pass on the plan proposed by the original Rapid Transit Commission presented the result of its investigations to the Supreme Court, and that report, in almost every detail, favored the plan proposed.

An Arabian Night's Entertainment.—The annual meeting of the New York Electrical Society, for the election of officers, reception of reports, etc., will be held on Thursday, July 14, 1892, at 7:45 P. M., at the Electric Club, 17 East Twenty-second stree. The business will be taken up at the time named without a minute's delay by the members in order that the second part of the evening's programme, which is open to all, may be carried out. Special arrangements have been concluded with the management of the Madison Square Garden, through the kindness of Mr. David Henderson, whereby the members of the society will attend the performance of "Sinbad" in the Garden Theatre at 8:15 P. M. This opera includes a large number of brilliant spectacular effects, utilizing the projection arc lamp in a way and to an extent never before attempted. After the performance members will be at liberty to ascend the tower and to enjoy the attractions of the Roof Garden, which include, not only a fine concert, but some beautiful decorative uses of the electric light. The price of the coupon ticket covering the whole entertainment, and insuring the best seats in the heatre, will be only $1. L. H. H.

Albany, July 9, 1892.

James R. Snell has been appointed general manager of the Amsterdam Electric Company.

The Union Electric Light Company, of Lansingburgh, proposes to establish a plant at once.

Thomas D. Mosscrop has resigned his position as general manager of the Amsterdam Electric Railroad. He will be succeeded by James R. Snell.

The large generators for the power house at Saratoga have been put in place. There is now sufficient power for very heavy traffic on the road. Double decked cars will be run on the road.

A belt line street railroad will be put in operation as soon as the new Albany and Bath bridge, for which the last Legislature granted a franchise, is constructed. It will connect Albany, Greenbush, East Albany and Bath.

Manager J. A. Powers, of the Glens Falls, Sandy Hill & Fort Edward Railroad, has appointed A. S. Crabell, formerly assistant superintendent of the Troy and the Lansingburgh Railroad, superintendent, and John Mahoney assistant superintendent.

The Gloversville Street Electric Railroad at a meeting of its directors elected the following officers: President, Daniel B. Judson; vice-president, S. H. Shotwell; secretary, Daniel F. Cowels; treasurer, A. J. Zimmer; attorney, William C. Mills.

Damage by Lightning.—When the storm of Wednesday night was at its height lightning struck the trolley wire of the electric railroad on Market street hill in Amsterdam. The lightning entered the station, and damaged the dynamo to the extent of $1,500.

The New York Rapid Transit Commission has appointed the Hon. John Bogart, of this city, chief engineer. This places Mr. Bogart in charge of one of the greatest engineering undertakings of the day, as the Commission's plans include an underground railway in Broadway.

Increase of Capital Stock.—At a meeting of the stockholders of the Albany Railway to-day, at which $700,000 worth of stock was represented, it was decided to increase the amount of the stock by $500,000, making in all a capital stock of $1,250,000. Of this amount $250,000 is to be expended in improving the equipment of the different lines of the road and $250,000 is to be expended in a year or so in meeting the bonds of the Broadway and Greenbush roads, recently acquired by the Albany Railway.

The Hudson River Telephone Company has begun to put down its cables, and the days of the overhead wires are numbered. Fifty pair cable is being used. The company's handsome new building is about completed, though it is not expected that the new system will be in thorough working order before Oct. 1 and perhaps not until Nov. 1. One of the latest improved switchboards will be put in and is now in course of construction by the Western Electrical Company, of Chicago. It is a metallic multiple switchboard, bridge system.

The injunction recently served upon the president of the Johnstown, Gloversville & Kingsboro Horse Railway Company, restraining that company from relaying rails for electric road purposes other than in the centre of the street, has been sustained by Judge Stover in a decision rendered a few days ago. It is not likely that there will be an appeal. The railroad authorities are willing to place their tracks in the middle of the street if the city authorities will stand between them and the Plank Road Company. It is said that the road will be built and necessarily an interesting litigation will follow between the railroad company and the Plank Road Company. In the meantime the directors of the Cayadutta Electric Railway Company have held an important meeting and will begin to lay the tracks for their line in about two weeks. R. V. T.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 28, Hathaway Building, 620 Atlantic Ave.,
Boston, Mass., July 9, 1892.

Mr. George Cutter, of Chicago, is now visiting the Hub.

Davidson Ventilating Fan Company has moved from 52 Pearl street to 34 Oliver street.

The Bruce Mica Mining Company has moved from 34 Oliver street to 25 Congress street.

Mr. Henry B. Cutter, general manager of the Cutter Electrical and Manufacturing Company, Philadelphia, is visiting Boston and made a call at our office.

The Automatic Rapid Lathe Company has been organized at Saco, Me., for the purpose of manufacturing machinery, with $250,000 capital stock. The officers are: President, F. Wood, of Boston, Mass.; treasurer, O L. Noble, of Boston, Mass.

A. A. Alden, of the Thomson-Houston company, who took the expert course at the works in Lynn, has accepted a position as superintendent of the lighting station at Bristol, R. I. F. R. Mowrer, another Thomson Houston expert, well known at the station, has accepted a position with the Thomson-Houston company, with headquarters at Cincinnati, O.

Mr. J. Y. Bradbury, of the well known Storage Battery Company of Lowell, the Bradbury-Stone Storage Battery Company, was a recent visitor to this office. He reports business as being very satisfactory, especially batteries used in connection with phonographs, having received orders recently for this class of work from Roanoke, Va., St. Louis and Louisville.

The West End Railway Company has sent 2,800 free tickets to the City Hall for the use of the children of the poor to ride to Franklin and Marine Parks. Two hundred each have been given to the aldermen and 400 to the mayor to be distributed. The company will furnish this number of tickets on the first day of each week during the months of July and August.

The Lynn & Boston Railroad Company has almost entirely completed the railroad line for the running of street cars by electricity from Lynn to Saugus and Cliftondale. It is busy setting up the Thomson-Houston electric generators in its new station on Washington street, where connections with the outer lines are made. Gangs of linemen and others are busy putting in trolleys for side tracks or "turnouts" on Summer street, and connections have been made with the main line on Andrew street to the new station. The company expects to give a practical trial test to some of the new machines, and will endeavor to run a car by electricity from Lynn to Saugus over the Summer street line.

Suit for Damages.—J. P. A. Hanlon, J. F. Hanlon and G. O. Hanlon, three brothers, seek to prove a claim of $10,000 against the estate of Herman D. Tewksbury, and they had a hearing before Justice Harriman in the Suffolk County Insolvency Court. Last July Tewksbury went into insolvency, and the claim against his estate is on account of damages alleged to have been done the Hanlons by reason of the failure of Tewksbury to perform a contract which all the parties had entered into The Hanlons had invented a device for an electric train alarm, and Tewksbury agreed to pay the expense of obtaining a patent, equip two trains with the alarm, and create a market for the advantageous sale of the stock of the Victor Electric Train Signal Company, a corporation which was organized and was assigned the patents It is claimed by the Hanlons that Tewksbury did none of those things. J. F. Hanlon testified that Tewksbury sold several thousand shares of treasury stock, and that the directors by agreement divided the proceeds among themselves and replaced the stock sold by that which they personally held. W. R. W.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, July 9, 1892.

Mr. John C. McMynn, of Cornell University, is a Chicago visitor this week.

Mr. Chas. F. G. Kopsch, Sydney, N. S. W., Australia, was a Chicago visitor last week en route home from London.

Mr. Morgan Brooks, of the Electrical Engineering and Supply Company, of St. Paul, Minn., was a welcome visitor in Chicago last week.

Mr. S. G. Booker, manager of the Fidelity Carbon Manufacturing Company, of St. Louis, Mo., secured some handsome orders in Chicago this week.

Mr. F. S. Blackall, general district agent of the Crocker-Wheeler Electric Company, of New York, is visiting friends in Chicago and St. Paul.

Mr. George Cutter, of Chicago, started on an Eastern tour on Tuesday and will visit several of the prominent summer resorts, and enjoy surf bathing before returning.

Mr. C. A. Daigh, vice-president of the National Electric Manufacturing Company, of Eau Claire, Wis., was in Chicago last week en route to the fishing grounds where he will pass his vacation.

Mr. E. V. Partridge, the manager of the Chicago office of the Ball Electric Light Company, is confined to his residence 5454 Woodlawn avenue, by an attack of malaria, but expects to be on duty again shortly.

Cutter's Magnetic Cut-Out, which was originally designed for use on railway cars, is also filling a want felt by users of stationary motors, so that George Cutter is turning out a new edition for this special purpose.

Mr. C. T. Page, secretary of the Englewood Electric Light Company, Chicago, has added three Westinghouse alternate current generators, one 500-h. p. Ball engine and one 300-h. p. Zell boiler to his Sixty-fourth street station.

The Cutter Electrical Manufacturing Company, Philadelphia, Pa., has just opened a Western office on La Salle street, Chicago, and Mr. Spofford, lately with the Consolidated Electric Manufacturing Company, Boston, will have charge of it.

Mr. J. Holt Gates, well known as the representative of the Westinghouse Electric and Manufacturing Company, and formerly having an office in Chicago, and later an office in Texas, has just been appointed general sales agent of the Siemens & Halske Electric Company of America, with headquarters in the Monadnock Building, Chicago.

Mr. H. S. Spier, at the last meeting of the Chicago Electrical Association, read a paper on "Pole Line Construction," in which he showed the steps which mark the change from the crude telegraph lines of forty years ago to the well built telephone circuits of to-day. In tracing the different features of the modern construction he touched on many amusing incidents connected with the older methods. He also showed how carefully the many details of line work have been worked out by the leading telephone companies, with a result that is familiar to all. The next meeting of the association will occur after the summer holidays, probably the second Tuesday in September. F. de L.

CANADIAN NOTES

Ottawa, July 9, 1892.

Belleville, Ont.—An application is about to be made for power to construct and operate an electric street railway in this city.

Rat Portage, Ont—Arrangements are being made for the formation of a company to construct an electric railway in this town.

Winnipeg.—Grading on the new electric street railway line has been completed about half way to the exhibition grounds, and rails have been laid as far as Slater street.

Lanark, Ont.—A bylaw to raise $4,000 for the purpose of purchasing for 20 years a water power for electric light purposes is to be voted upon on July 4 by the ratepayers of Lanark.

Toronto.—Within the past few days some changes have taken place in the directorate of the street railway company. Wm. McKenzie is now president of the road Mr. Geo. W. Kiely having sold out to the former.

The Consolidated Electric Company, of St. John, has completed an electric lighting plant for Messrs. C. F. Stacey & Co., of Bathurst. The plant consists of one of the dynamos of the company, two 1,200-c. p arc lights, ten 24-c. p. and twenty-four 16-c. p. incandescent lights.

London, Ont.—As a result of the offer of a new company to establish a system of electric railways in the city, the president of the London Street Railway Company has written that his company is prepared to make the necessary extensions and to convert its present system into one run by electricity instead of horses.

Ottawa, Ont.—There is a probability of the electric cars required for the Toronto service being manufactured in Ottawa. A number of the directors of the company were in Ottawa recently and procured contract prices from Mr. Wylie, who has already turned out a number of splendid open cars for the company in this city.

Montreal.—A meeting of the board of directors of the Montreal Street Railway Company has been held, at which Mr. James Ross was elected president and Mr. Avertet a director. Owing to the absence of Ald. Prefontaine, the meeting of the committee to deal with the tenders for the electric service has been postponed. Mr. Ross will soon return from England.

St. John, N. B.—The Consolidated Electric Company is making some changes in its station, in order to accommodate more engines and other machinery for its rapidly growing business, as well as to provide room for the balance of the machinery now at the old station of the New Brunwick company, and the new street railway generator. In order to provide for these changes a new building will be constructed.

Ottawa, Ont.—At the first annual general meeting of the shareholders of the Ottawa Electric Street Railway Company, held yesterday afternoon, the directors' report recommended that a dividend of seven per cent. be declared. In order to meet the ever increasing traffic, and continue to keep the service in its present state of efficiency, several additional new cars have been ordered to be built in Ottawa.

Brantford, Ont.—The present street railway company is an entirely new concern with these officers: President, Mr. Darling, ex-president of the Bank of Commerce; vice-presidents, Mr. Insull, second vice-president of the Edison Electric Company, new, and Mr. M. D. Barr, district agent of the Edison company of Canada. The contract for the line is at present laid out, and work will be started almost immediately.

Ottawa, Ont.—Few people seem to be aware that the Ontario Legislature has sold the electric power rights on the Canadian side of the Falls for 100 years for $25,000 for the first 10 and $30,000 thereafter. The owners of the monopoly are the same company who control the American side of the river. They paid in $50,000 in cash to the treasury at Toronto the other day on account of rent, and will begin the work of construction at once.

British Columbia.—A few weeks ago a delegation waited on the government at Ottawa, and asked that the rails used in electric railways which weighed over 30 pounds be admitted free of duty under the same classification as rails used for locomotives. The government forwarded a reply recently, stating that electric railways are classified as tramways, and the rails used for electric railways are dutiable, irrespective of weight.

Toronto, Ont.—The following companies are announced as incorporated: The Citizens' Telephone and Electric Company, Rat Portage, capital $40,000; the Manitoulin & North Shore Telephone and Telegraph Company, capital $20,000. The Southern Telephone Company, with capital of $80,000, is seeking incorporation to work from Scattale, through Louisburg, Gabarus and St. Peters, to Port Hawkesbury. The Eastern Telephone Company, whose system is confined to Cape Breton County, has over one hundred instruments in use.

Halifax, N. S.—John Starr, Son & Co., the electrical supply house of Halifax, is doing a large trade all over Canada and Newfoundland as well as the United States, in specialties which it owns and controls. It has established a number of electric light and telephone companies in the province and Newfoundland, and is now engaged on a large contract with the Valley Telephone Company of Middleton, which are running lines throughout the Annapolis Valley, and will have exchanges in over a dozen different towns through which its lines run, thus completing connection between Halifax and Yarmouth.

Montreal.—A deputation from the Bell Telephone Company and G. N. W. Telegraph Company interviewed the Minister of the Quebec Government in opposition to the clause in the Montreal City bill imposing a tax on telephone and telegraph posts and wires. The Bell telephone represen atives said that this tax would mean $15,000 out of the pockets of the company, and it would be obliged to increase rates, while others held that this was an unfair method of taxation, and if it became general in the Province it would mean the ruin of the company. The Premier replied that as this was a private bill the government could not interfere, but they would consider the matter as individuals and act accordingly.

Montreal.—The City Council had a stormy meeting recently the bone of contention being the electric railway question. The special committee appointed by the Council to consider the various tenders reported in favor of the tender of Mr. Williams, representing a New York syndicate. The other tender was from the Montreal Street Railway Company, which has still an eighteen years' franchise. After the report had been read, Mayor McShane announced that he had received another tender, and asked the Council whether

it would be received. An excited discussion ensued, several of the aldermen protesting against a new tender being admitted after the committee had made its report. Finally the Council agreed to receive it. The tender was from A. W. Morris, representing a wealthy syndicate, and it offered to introduce an electric system, paying the city a percentage on the net earnings, as follows: For the first five years, 1¼ per cent. per annum; second, 2¼ per cent.; third, 3¼ per cent.; fourth, 4¼ per cent.; fifth, 4½ per cent.; or, for the first five years, ½ of 1 per cent. per annum on the gross earnings; for the second five years, 1 per cent. per annum; for the third five years, 2 per cent. per annum; for the fourth and fifth five years, 3 per cent. per annum. Or, for the first five years, $110 per mile; second, $210; third, fourth and fifth five years, $310. The question was again deferred. The struggle for the valuable franchise now lies between the street railway company, the New York syndicate and the Morris syndicate. The general impression is that the street railway company will win in the end.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, June 30, 1892.

Electric Coal Cutting.—A company called the Electrical Coal Cutting Contract Corporation has just been formed with a capital of £400,000 for the purpose of working a large number of electrical mining machinery patents.

Municipal Electric Lighting.—The Vestry of Islington (London) and the Town Council of the ancient city of Worcester have both decided to go in for electric lighting. The latter proposes to spend some £16,000 and to employ water power in combination with steam. Last week the Town Council of Taunton decided to purchase the electric light works of the local lighting company, which has for some time past been pioneering under considerable difficulties in this locality.

London County Council Overhead Wire Regulations.—In December last the County Council published some by-laws with regard to overhead wires in the metropolis, which to the casual reader appeared unexceptional. However, the National Telephone Company and other corporations, who run overhead wires in London, think otherwise, and recently induced the electrical trade section of the London Chamber of Commerce to consider these rules and to petition the Board of Trade on the subject.

Lane Fox Patent.—The action brought by Mr. Lane Fox against the Kensington & Knightsbridge Electric Lighting Company on account of their alleged infringement, covering, as he claims, parallel distribution with secondary batteries as "reservoirs of electricity," came before the Court of Appeal on Monday. Mr. Lane Fox is conducting his case in person, and it will be interesting to observe whether the inventor's advocacy of his own claims meets with better success than in the court below, when Mr. Lane Fox had the benefit of one of the ablest counsel at the bar.

Club Lighting.—A most important and significant meeting has been held of the secretaries of several of the best clubs in London, the meeting having been called together for the purpose of protesting against what is considered to be the onerous charges of the electric lighting companies. There can be little doubt that owing to the rose colored statements made by many eminent authorities, the public have generally failed to realize that unless their lighting bills are to be of the most extravagant description they must be economical in their use of electricity. To a casual observer it would seem as if the generality of customers were not only anxious to have the most expensive light, but were inclined to use it far more than its cheap and nasty competitors.

Military Telegraphy.—A smart feat was performed a short time ago by the Royal Engineers' Telegraph Battalion attached to the Aldershot Division. A long line was laid in the dark over some of the roughest ground imaginable and enabled the officer commanding the troops not only to find a brigade, which had lost its way in the dark, but to control the simultaneous advance and attack of three separate brigades on an earthwork at midnight. At the time of the manœuvres last year an attempt was made to produce on a map at headquarters a plan of a battle step by step as it progressed several miles away. The attempt was only a qualified success, owing to the maps available being on too small a scale. The experiments demonstrated, however, the feasability of such a plan with sufficiently large maps.

Post Office and the Telephones.—The select committee appointed to consider the bill recently introduced by the Postmaster General for the purchase of the telephone trunk wires of the country, and to confer upon the telephone companies some of the compulsory powers possessed by the Post Office, held only two sittings and then reported to the House of Commons. The chairman of the National Telephone Company, who was one of the witnesses, admitted that his company conducted a large portion of its business in a remarkably inefficient manner, but said that this was the fault of Parliament in not giving the company the necessary powers. The government should either take the telephones over altogether or allow them a free hand. The witness did not appear to be at all prepossessed with the government half way house scheme. A member of the Post Office staff, Mr. J. C. Lamb, who was one of the committee, neatly cornered the chairman of the National company on this point by the innocent inquiry whether it was the fault of Parliament that the National company did not run metallic circuits! The report of the committee, which was as brief as its consideration of the bill, advised the Legislature to leave the settlement of details to the Post Office, but emphatically deprecated the extension of the duration of the licenses at present held by the companies, which have still 19 years to run. This is worth noting, since it tends to strengthen the impression which one gets from the Post Office officials themselves, that one of the first tasks of the new Parliament will be to pass a bill purchasing the entire telephone system of the country.

News of the Week.

THE TELEPHONE.

Saratoga, N. Y.—The telephone line between Saratoga and Glens Falls has been completed.

Dallas, Ore.—The contract for the construction of a telephone line from Dallas to Salem has been let.

Spokane and Waterville, Wash., will probably be connected by telephone in the near future.

Colorado Springs, Colo.—The Western Union Telegraph Company has started the construction of a wire from Colorado Springs to the summit of Pike's Peak.

The Chicago Telephone Company proposes to increase its capital stock to $5,000,000 for the purpose of extending its system in the city and of making adequate connections with the World's Columbian Exposition.

Philadelphia, Pa.—The Bell Telephone Company has established a uniform rate of $120 per year to all subscribers between the Delaware and Schuylkill rivers and Vine and South streets. This will affect at least 250 subscribers, who will have to pay $60 additional per mile.

THE ELECTRIC LIGHT.

Hudson, Mich., is to have an electric light plant.

Homer, Mich., is to light its streets by electricity.

Sanborn, Ia., has decided in favor of the electric light.

Elkton, Md., has made a contract for street lights for next year.

Bristol, Conn., has decided by a vote of 211 to 90 to have electric lights.

Northfield, Minn.—An electric light company is being organized at Redwood Falls.

Des Moines, Ia., has decided by an almost unanimous vote to have an electric light plant.

Granite Falls, Minn.—The electric light plant has been started and is in successful operation.

Kingwood, W. Va., wants electric lights and is looking for outside capital to put in the plant.

The Edison Light Company, of York, Pa., has ordered two 300-h. p Corliss engines for its plant.

Lansing, Mich., has voted to own its electric light plant. The present plant will probably be purchased at a cost of $60,000.

Chicago, Ill.—A resolution has been introduced to the county board for the establishment of a new electric light plant at the county hospital.

St. Peters, Minn.—The new electric light plant has started up and is furnishing 45 arc lights for the streets and 1,000 incandescent lights for private work.

The Directors of the Toledo Electric Light Company are discussing the question of the site of the new electric light plant, which it is estimated will cost about $100,000.

Spokane, Wash.—The Edison Electric Light Company is to install a special incandescent lighting plant in order to supply the more remote residence portion of the city, and it is expected that the plant will be in operation by Aug. 1.

Valparaiso, Ind.—A fire recently destroyed Wilson & Vanness' incandescent electric light plant. The loss to the company will probably aggregate $15,000, with about $5,000 insurance. The plant will be rebuilt, but will require some two months before it is again in operation.

Pittsburgh, Pa.—The Allegheny County Light Company's property has been sold to Messrs. Lysle & McCance for about $55,000. The Lighting Company is building on its new property, Twelfth and Etna streets, and from this plant it will supply all the lights for Pittsburgh and Allegheny.

Superior, Wis.—The Water, Light and Power Company has secured the contract to equip the whaleback steamers, Pillsbury and Washburn, with complete electric light plants. Each vessel will have a 150-light marine dynamo, and the work will be done in strict accordance with the requirements of the United States Navy.

The Augusta (Ga.) Railway and Electric Light and Motor Company is installing three 80 light, 2,000 c. p. Wood arc dynamos, a 1,300 light Slattery alternator to be driven by a Victor horizontal turbine, a new metallic motor circuit and a steam plant consisting of an 850 h. p. Corliss engine and Babcock & Wilcox boilers.

St. John, N. B.—A 600-light Brush alternating current incandescent plant is being installed, which is expected to be in operation by Aug. 1. The electric light station which was destroyed by fire in November last has been replaced by a substantial brick building, and two Leonard-Ball engines of 80-h. p. and 45-h. p. respectively have been added.

Pittsburgh, Pa.—On the evening of July 4 a novel electrical display took place at the residence of Mr. Howe, of the Orr & Howe Electric Company. Two hundred 6-c. p. red, white and blue incandescent lights were hung in festoons and groups of five. A revolving pin wheel, roman candles, stars and colored reflections of sprays were other interesting features.

THE ELECTRIC RAILWAY.

Cape May, N. J.—The electric railway has been opened.

Detroit, Mich.—The General Electric Company's engineer has arrived and begun work on the Fort Wayne & Belle Isle road.

New Haven, Conn.—The superintendent of the Morris Cove electric road says that the written consent of almost every property owner along the shore at Morris Cove has been obtained for the proposed road.

Fond du Lac, Wis.—It is reported that George B. Hathaway is negotiating for the purchase of the street railway system of Fond du Lac, and if it passes into his hands it will undoubtedly be equipped with electricity.

Chicago, Ill.—An ordinance has been introduced to grant an extension of the Chicago & North Shore electric road from Graceland avenue to Dewey Court, with the intention of providing a continuous line of rapid transit from the downtown districts to Evanston.

Milwaukee, Wis.—The first car has been run over the line of the Milwaukee & Wauwatosa Electric Company. Work is being pushed on the engine house at Wauwatosa, but it will be several weeks before it will be completed. The road will be operated in connection with the Milwaukee street railway line.

The Astoria Electrical Manufacturing Company is running a storage battery car daily on the Steinway & Hunter's Point Railway, with a new type of battery weighing 27 pounds per cell, where, it is said, the usual types of the same capacity weigh 40 pounds per cell. The battery stands heavy discharges with very small drop in voltage, and is, therefore, well adapted to car work. The positive grids are more durable than those of the usual types, as they are not attacked by the acid and are elastic enough to expand without breaking. The performance of the car is perfectly satisfactory, and the company is going ahead on a commercial basis and is already negotiating with three different roads with a view to equipping them with battery cars.

MISCELLANEOUS NOTE.

Tulane University, of Louisiana, has issued its annual catalogue and also a pamphlet concerning the course in electric engineering. During the past year extensive additions have been made to this course, including a complete plant of the Slattery induction system, a Wood arc lighting dynamo, an Edison General Electric Company's arc machine and four smaller Edison incandescent machines. Special attention is given to the study of alternating current phenomena and every encouragement is given to post-graduate and advanced work.

Industrial and Trade Notes.

Carbon Sales.—The Central Electric Company reports a very lively demand for arc light carbons. The company is the general Western agent for the Washington carbons.

A New Catalogue.—We are in receipt of a neat catalogue from the Consolidated Electric Manufacturing Company, which gives a good illustration and description of its new Lyon brake.

The Central Electric Company, of Chicago, has just gotten in a consignment of Lumell fan motors, and they are making a breeze, which is needed at this particular time of the year.

Wm. McFarlane & Company, Grand street, New York, make a specialty of silk thread for the winding of electric wires, and there is always a demand for this well known form of insulation.

The Brush Electric Company, of Atlanta, Ga., has transferred its office from the Gate City Bank Building to room 78 Old Capitol Building, where the agent, Mr. S. W. Trawick, may now be found.

Okonite Sales.—The Central Electric Company reports the sales of okonite for the past week as almost equal to the sales of the preceding week, which was the largest in the history of the company.

The Hazelton Boiler Company, 716 East Thirteenth street, has just shipped one 500-h. p. porcupine boiler to the Edison Illuminating Company, of Rochester, that company already having a 3.0-h. p. boiler of the same make.

A Correction.—In a recent issue it was stated that the Ball Engine Company had shipped three 300-h. p. cross compound engines to the Jersey City & Bergen Railroad Company. This was a mistake, for this order was secured and filled by the Ball & Wood Company, 15 Cortlandt street, New York.

Julius Lefman, of St. Louis, Mo., manufacturer of three joint iron and steel railway poles, has issued a catalogue containing illustrations and descriptions of the many forms of poles manufactured by him, as well as cross arms, pole tops, pull overs, and various other electric railway line supplies.

F. Holman & Co. has reorganized under the name of the F. Holman Electric Company. Mr. Holman will hereafter give his personal attention to the manufacture and sale of the "Paradox" reflectors. These reflectors are very ornamental in finish, and are guaranteed to retain their reflective power for three years.

The Central Complete Combustion Manufacturing Company, 13 Park Row, New York, manufacturers of the well known down draft boilers, is issuing a catalogue setting forth the merits of this boiler. Some excellent points as to efficiency, economy, etc., are claimed, supported by some strong testimonials.

Priestman & Company, of Philadelphia, is sending out a catalogue descriptive of the Priestman oil engine, and containing some interesting tables comparing the cost of operation with that of other engines, showing remarkable economy. Endorsements from such men as Sir. Wm. Thomson, Dr. Coleman Sellers and Prof. Unwin are given.

The Electric Appliance Company reports great success in the introduction of mica asbetite railway appliances. This materia is receiving favorable comment from every one familiar with the requirements of electrical railway construction, and a large number of western railroads are giving the material the severest test with the best possible results.

The Buckeye Electric Company, of Cleveland, O., has removed its New York office to Room 611-612 Mail and Express Building. The new offices are nicely appointed and conveniently located. Mr. F. H. Prentiss, who represents the company in this vicinity, would be glad to have his friends and customers call and inspect the new quarters.

The Ball Engine Company, of Erie, Pa., has received an order from the Englewood Electric Light Company, of Englewood, Ill., for a 500 h. p. latest improved Ball cross compound engine, and one from the Port Huron Electric Railway Company, Port Huron, Mich., for a 400-h. p. cross compound of the latest type. The North Hudson County Railroad Company, of Hoboken, N. J., last March purchased a 300-h. p. improved Ball engine and has been so well satisfied that it has ordered another engine of the same power from the Ball company.

The New York Insulated Wire Company is to furnish the wire to the Westinghouse Electric and Manufacturing Company for the entire incandescent lighting of the World's Fair buildings and grounds. The well known Grimshaw white core wire, cables, tapes and compounds are to be used throughout for the 92,000 incandescent lamps, as well as for many of the arc lights and motors. Although over 15,000,000 feet of wire will be required, the company will still be able to supply promptly any other orders received.

Messrs. W. R. Fleming & Co. are now nicely settled in their new offices in the Mail and Express Building, and the sale of Ide and Ideal engines goes on rapidly. Among the recent installations are those of the Alexandria (Va.) & Mount Vernon Street Railway, Chillicothe (O.) Electric Light and Railway Company, Georgetown (D. C.) & Tenallytown Street Railway, a municipal plant to the borough of South Norwalk, the first plant of its kind in Connecticut to be operated by town officials, and a lighting and pumping plant for the Hotchkiss Yale preparatory school at Lakeville, Conn.

The International Ore Separating Company, New York, in a recent communication states, in reply to certain statements made by other parties, that no service nor attempted service of suit by any officer of the court or other person was made upon the International Ore Separating Company until after the denial of suit published by the company and its expressed readiness to prove its claims before any court, as given under date of June 18, 1892. As previously stated this company is prepared to protect its patents and will guarantee full protection to all its customers in their use of its machines or patent rights.

The Purity Oil Filter Manufacturing Company, Pittsburgh, Pa., has recently received the following orders for the Ideal Steam Oil Refiner: Wray Electric Engineering Company, Bradford, Eng.; Pearson Cordage Company, Boston, Mass.; Schumlbach Brewing Company, Wheeling, W. Va.; Granite Mountain Mining Company, Rumsey, Mont. (which is the second order in two years); McIntosh-Huntington Company, Cleveland, O.; Crook, Horner & Co., Baltimore, Md., who will be the company's agents in that city; Bemis & McLenan, who will represent the company in Chicago, Ill., and Edward Lassell, Kansas City, Mo., will be the representative in that city. Many applications for agencies in various parts of the country are reported.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

The New York office of the Consolidated Electric Storage Company, 120 Broadway, is the sole agency for the sale of storage batteries for New York and vicinity. Purchasers desiring to secure the best terms should apply at that office to E. J. Moore, manager.

Every Progressive Electrician Should Have It.—The Colburn Electric Manufacturing Company of Fitchburg, Mass., in a recent communication to THE ELECTRICAL WORLD, states the following in regard to "Houston's Dictionary of Electrical Words, Terms and Phrases": "Yours at hand; also 'Houston's Dictionary.' We consider this a first class work and it should be in the hands of every progressive electrician."

Pullman Vestibuled Buffet Sleeping Car Service—Chicago to Portland, Me.—Commencing June 26, and continuing through the tourist season, the Chicago & Grand Trunk Railway will run a Pullman vestibuled buffet sleeping car of the most modern pattern, through without change, from Chicago to Portland, via Toronto and Montreal, leaving Chicago 3 P. M. daily except Saturday, arriving at Portland for breakfast second morning. On this train there will be a Pullman car for Old Orchard Beach, and tourists for all North Atlantic seaside and mountain resorts will find this improved through service worthy of patronage. Secure sleeping car reservations and further information by applying to E. H. Hughes, General Western Passenger Agent, No. 103 S. Clark street, Chicago.

Two Harvest Excursions—Half Rates to the West.—August 30 and September 27—on these dates the Burlington Route will sell tickets from Chicago, Peoria and St. Louis to the farming districts of Nebraska, Colorado and Northern Kansas. Half rates will apply, and tickets will be good for 20 days. Nebraska in one year produced 300,000,000 bushels of corn, besides other grain, fruits and live stock. Write for free pamphlets, etc., to P. S. Eustis, G. P. A., Burlington Route, Chicago, Ill.

Summer in Colorado.—If you are calculating on spending your summer vacation in Colorado you should consider the most comfortable way to get there. The handsomest train in the world runs daily from Chicago to Pueblo, Colorado Springs, Manitou and Denver, without change, over the Santa Fe Route. There is no other through car line to Manitou, the great Colorado resort. You must transfer and change cars if you go any way other than over the Santa Fe Route from Chicago. Don't forget this, it is an important fact. A through car runs on through Manitou, Ute Pass, Cascade Canon, Green Mountain Falls, Buena Vista and Glenwood Springs to Ogden and Salt Lake City, without change from Chicago. On any other line you can't do it. For further information address J. M. Connell, City Passenger Agent, 212 Clark street, Chicago.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

[In Charge of W. A. Rosenbaum, 177 Times Bldg., N. Y.]

U. S. PATENTS ISSUED JULY 5, 1892.

478,097. Electric Measuring Instrument; Sydney Evershed, London, England. Application filed Dec. 18, 1891. In an electric measuring instrument, a coil and blocks of magnetic material arranged therein, in combination with an arbor placed longitudinally in the axis of the coil and carrying a piece of magnetic material adapted to move always with its length parallel to the lines of magnetic force between the blocks and means for controlling the movement of the piece.

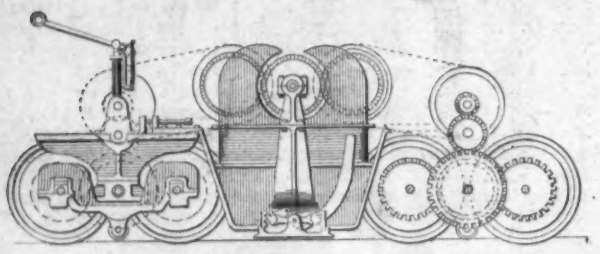
478,098. Apparatus for the Measurement of Electrical Resistances; Sydney Evershed, London, England. Application filed Dec. 22, 1891. In an ohmmeter for the measurement of large resistances, a large current coil wound with a large number of turns of fine wire, in series with the circuit to be tested and closely surrounding a pivoted magnetic needle and an index finger, in combination with a pressure coil or coils in shunt with the circuit to be tested and with its magnetic axis at right angles to and intersecting that of the current coil.

478,104. Brush Holder for Dynamos and Motors; Merrill H. Hathaway, Springfield, Mass. Application filed Oct. 8, 1891. In a brush holder, a holder-body provided with a removable bottom and having its rear end piece connected to or formed integral with said bottom, a follower guided within the body, a notched or toothed stem passing through the rear end piece for advancing the follower within the body, a detent engaging the notches or teeth on the stem for holding it against rearward movement, and means for locking the removable bottom and rear end piece upon the body.

478,138. Electric Mine Car; Elmer A. Sperry, Chicago, Ill. Application filed Feb. 16, 1891. In a motor tram car, pivotal truck or trucks, axles mounted on the trucks, provided with traction wheels, a shaft mounted upon the car, a wheel mounted upon the shaft by a universal joint connection in engaging contact with wheels mounted on the axles of the truck, and devices upon the wheels adapted to maintain the universally mounted wheel in alignment with the wheels on the axles of the track. (See illustration.)

478,139. Electric Locomotive; Elmer A. Sperry, Chicago, Ill. Application filed April 8, 1891. In a system of power transmission for an electric machine, an axle, an armature provided with a hollow spindle mounted on the axle, a bushing surrounding the axle, an elastic supporting medium between the bushing and the hollow spindle, and oil guards at the ends of the spindle.

478,140. Trolley Wire Splice; Elmer A. Sperry, Chicago, Ill. Application filed April 18, 1892. The combination of two trolley wires approaching each other, a coupling substantially larger than the trolley wires for resisting the strain and coupling the wires, two tapered clamps located one each side of the coupling, and a metallic connection or bridge piece connecting the clamps.



No. 478,138.—ELECTRIC MINE CAR.

478,142. Dynamo-Electric Machine or Motor; Elmer A. Sperry, Chicago. Application filed Nov. 16, 1891. A magnet frame or body for an electric machine, consisting of a U-shaped casting without joint in the magnetic path and without bed frame or bed plate, way grooves in the body for its support, and brackets integral therewith extending laterally and upwardly from the horizontal portion of the magnet body for the support of the journals.

478,145. Electric Arc Lamp; Elihu Thomson, Lynn, Mass. Application filed March 22, 1890. The combination, with an arc light carbon, of an electric motor constantly in operation, and a speed-responsive device connecting the carbon with the motor, so as to be actuated thereby upon a variation from the normal speed of the motor.

478,149. Incandescent Electric Lamp Socket; Henry Elmer Werline, Lancaster, Pa. Application filed Dec. 22, 1891. In an electric lamp socket, a series of connected resistances and connecting springs, the latter serving to give stiffness.

478,152. Device for Reproducing Characters; Henry C. Bridger, Wood Ridge, N. J. Application filed Aug. 10, 1891. The combination, with a table having a to-and-fro and a lateral movement of a pen-supporting arm adjustably mounted over the table, and independent mechanism for causing each of the movements.

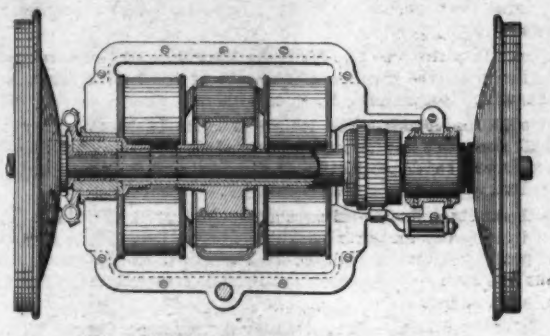
478,175. Electric Railway Conduit; Milton Shoemaker, Sioux City, Ia. Application filed May 25, 1891. In an electric railway system, a trolley rail consisting of a metal tube extending longitudinally inside of an underground metal case, the metal tube being set in glass insulators, and means for rigidly holding it in place therein, a suitable conductor, and suitable means for holding it in place on the metal tube, the metal tube being provided with glass connections at all points of connection between it and a service pipe for forcing hot air from a hot-air furnace into and through the metal tube.

478,182. Electrical Distribution for Cars; Samuel Young, Morris Moskowitz, Leon D. Adler and Joseph Lowenberg, Newark, N. J. Application filed Oct. 15, 1891. In a system for electrically lighting cars, in combination with the pivoted truck of a car, a pair of air-compressing cylinders arranged directly upon a truck, the cylinders being provided with valves on their opposite sides, eccentrics arranged on and moving with the car-wheel axle of the truck and the eccentrics being directly connected with the piston rods in the cylinder, pipes leading from the cylinders, flexible tube connections, and pipes extending into the car body, an air engine provided with valve chests with which the pipes extending into the car body communicate, and a dynamo connected with the engine.

478,183. Electric Car Lighting System; Samuel Young and Morris Moskowitz, Newark, N. J. Application filed Jan. 13, 1892. In a system for electrically lighting cars, in combination, an air compressor on the truck of the car, an eccentric for driving the same, an air receiving tank, an air engine and dynamo, pipes connecting the same, and an automatic regulating device to decrease the pressure of air in the receiving tank, consisting, essentially, of a cylinder provided with a slide valve having ducts, an air chamber, a pipe connecting the chamber with the air or storage tank, and an exhaust pipe leading from the cylinder.

478,186. Electric Lighting System; Edward R. Cooke and William H. Mackay, St. Louis, Mo. Application filed July 17, 1891. A system of lighting and extinguishing electric lamps from one or more points, consisting of a circuit, a switch carrying two suitable contact plates for making and breaking the circuit, two magnets governing the switch, one of which operates the switch to make the circuit and light the lamps and the other of which operates the switch to break the circuit and extinguish the lamps, a circuit in which each of the magnets is arranged, a third contact plate carried by the switch, adapted to break the circuit of the actuating magnet and establish the circuit of the other magnet, the third contact plate being connected to one terminal of the circuit containing the lamps and manually operated devices controlling at will the circuits of the magnets to light and extinguish the lamps.

478,201. Electrical Brazing Device; Willis Mitchell, Malden, Mass. Application filed Aug. 17, 1891. In combination with a carbon cup forming one electrode of an electric circuit and adapted to receive and support a ring or rings upon it, a movable carbon pencil forming the other electrode of the circuits and adapted to be introduced into the cavity of the cup.



No. 478,242.—ELECTRIC LOCOMOTIVE.

478,230. Secondary Battery; James H. Gerry, Brooklyn, and Charles E. Long, New York, N. Y. Application filed Aug. 1, 1891. In a secondary battery, the combination, with a cell containing shallow compartments or troughs formed by insulating partitions and containing active materials, of lead plates arranged in the cell with their lower edges extending down into the active material.

478,237. Time-Registering Apparatus for Electricity; Henry H. Pattee, Monmouth, Ill. Application filed Dec. 11, 1891. The combination, with a source of electricity, of one or more translating devices arranged in a circuit therefrom, an electromagnet, also arranged in the circuit, a switch to control the circuit, time-registering mechanism, and means operated by the electromagnet to automatically stop or start the time-registering mechanism, and means, also operated by the electromagnet, to automatically cut the electromagnet out of circuit.

478,242. Electric Locomotive; Sidney H. Short, Cleveland, O. Application filed Nov. 6, 1890. The combination, with a hollow shaft, an armature and a driving axle, of the coupling comprising the forks, the arms and insulating spring pads. (See illustration.)

478,245. Magnetic Lock; Henry Vincent Smith, South Yarra, Victoria. Application filed Dec. 18, 1891. In a magnetic lock, the combination of a permanent magnet, the pivoted latch adapted to be drawn into a recess by action of the magnet, and means on the catch whereby it may be disengaged from the magnet and recess.

478,274. Electric Indicator; William E. Decrow, of Boston, Mass. The combination with an indicator, having a series of numbered parts, of electrically controlled means for moving the parts so as to give a desired indication, and a resetting device controlled by said means and timed to reset the indicator after a definite lapse of time.

478,275. Suspension-Bar for Electric Lamps; Thomas Dillon, Indianapolis, Ind. Application filed April 28, 1892. A suspension bar consisting of a bar of wood or other non-conducting material and a pair of metallic discs mounted on the opposite ends of the bar, and each provided with a peripheral groove and a binding post adapted to receive an electric conductor.

478,276. Rheostat; Winslow P. Eayrs, Nashua, N. H. Application filed Aug. 3, 1891. In a device for regulating electric lights, two resistances and contacts therefor, two sets thereof being connected, respectively, with said resistances, corresponding contacts in each set being connected with their respective resistances at similar points, the resistances being respectively always in contact with the legs of a main circuit and corresponding contacts being movable and adapted to be brought in pairs successively in contact with the legs of a local circuit.

478,293. Voltaic Glove; Frederick Simpson, Boston, Mass. Application filed March 25, 1892. In a glove or like article of hand wear, wire gauze strips or plates of copper and zinc secured therein near the edges of the slit or opening for the hands, a connection of some electric conducting material, a suitable binding for the said metal, and suitable openings in the binding to permit contact of the metals with the flesh.

No. 478,410.—TROLLEY.

478,324. Indicator for Electrical Signaling Systems; Charles F. Gillette, New York. Application filed Aug. 13, 1891. A magneto-electrical generator attached to back of plate and card-holders, contact-points, and contact-arm on front of plate and electrically connected with magneto-generator.

478,344. System of Electrical Distribution; Harry Ward Leonard, New York. Application filed Nov. 27, 1891. The herein-described method of varying the speed of an electric motor, which consists in maintaining its field-magnet at a constant strength and connecting its armature terminals with one or another of two or more constant potential sources, the potentials of which are different.

478,346. Electric Railway; Frank Mansfield, New York. Application filed Nov. 18, 1890. In an electric railway, the combination, with a car provided with a contact device, of a conduit having a guide-slot extending along the roadway, and movable contacts arranged along the way, and movable contacts adapted to be brought into engagement with the contact device on the car, and a movable pick-up plow mounted on the car and hinged so that it may be moved into and out of the guide-slot, and a lock for holding it elevated out of the slot.

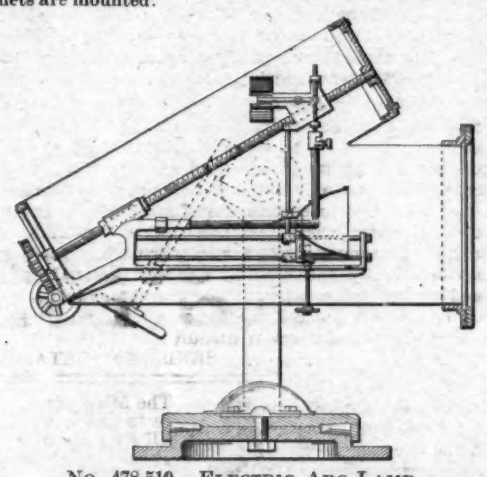
478,367. Electric Cable; William Henry Sawyer, Providence, R. I. Application filed Feb. 18, 1892. In an electric cable, the combination of a solid central foundation-core and a tubular multi-conductor braid formed thereon and supported thereby, the said tubular braid being composed of two pairs of insulated conductors braided or woven together in a uniform helical direction, the plane of the cross-section of each of the two pairs being at a right angle to and bisecting that of the other.

478,383. Lightning Arrester; Charles S. Van Nuis, New Brunswick, N. J. Application filed Sept. 16, 1891. A lightning arrester consisting of an insulating bead or similar connecting device and fusible wires connected thereto on different sides by being wound around the same, the outer ends of the wires being held by a suitable support.

478,410. Trolley; John W. Davis, Lynn, Mass. Application filed Oct. 22, 1891. A trolley consisting of an elongated body having tapering ends, with a central groove and spiral grooves about the tapered portions, communicating therewith, the grooves extending into the body of the material and the flanges bounding the grooves being integral with the body portion. (See illustration.)

478,417. Swing-Joint for Electric Light Bracket; Henry P. Drew, New York. Application filed March 15, 1892. In a swing-joint, two cupped joint sections, branches thereon, perforated and threaded to receive pipes and further perforated to connect the threaded perforations with the cupped cavities of the joint sections, a headed coupling bolt loosely engaging one joint section and locked to the other joint section, a washer between the joint sections, a washer under the coupling bolt head, a clamping screw bolt engaging a tapped axial hole in the other end of the coupling bolt, and a washer between the locked joint section and the head of the clamping screw bolt.

478,475. Electric Motor; Jerome B Secor, Bridgeport, Conn. Application filed Jan. 30, 1891. In an electric motor, the combination of a base of magnetic material, a series of radial field magnets whose cores are magnetically connected with the base, a commutator and electrical connections adapted to energize the magnets successively, and a concentric non-wound and non-magnetized armature of magnetic material provided with inwardly projecting teeth, which approach the poles of the respective magnets successively and having its lower portion revolving in close proximity to the base upon which the field magnets are mounted.



No. 478,510.—ELECTRIC ARC LAMP.

478,477. Electric Locomotive; Sidney H. Short, Cleveland O. Application filed May 26, 1891. The combination with an electric motor encircling the axle of a car or other vehicle, of a series of guard bars extending beneath the motor and serving to protect same from injury.

478,485. Electric Battery; Charles F. Waldron, Boston, Mass. Application filed Aug. 22, 1891. A battery element consisting of a wooden base or blanket of a practically rigid character and a metallic plate presenting a surface of active material in immediate contact with the base or blanket, the parts together constituting a horizontal tray and remaining in permanent contact without intermediate spacing.

478,493. Microtelephonic Apparatus for Divers; Robert Wreden, St. Petersburg, Russia. Application filed March 28, 1890. The combination with a helmet provided with binding posts in electrical communication with conducting wires with a bandage adapted to be placed on the diver's head and provided with a receiver and a microphone, and conducting wires leading to the binding posts.

478,510. Electric Arc Lamp; Rudolph M. Hunter, Philadelphia, Pa. Application filed Nov. 12, 1891. In an arc lamp, the combination of a main frame, a holder for one of the carbons, carried by the main frame, a carriage or movable part, a holder for the other carbon carried by the carriage or movable part and adapted to hold the last mentioned carbon at an angle to the first mentioned carbon, feeding devices consisting of a screw for feeding the carriage at an angle to the first mentioned carbon and its holder, and hand-operated devices for rotating the screw. (See illuustration.)

478,518. Insulator; Louis McCarthy, Boston, Mass. Application filed April 11, 1892. An insulator comprising metallic portions separated by an interposed series of sheets of mica compressed together, securing devices by which the metallic portions and mica are secured together, a mass of insulating material in which the metallic portions and sheets of mica and their securing devices are imbedded, and an outer metallic covering or case.

478,522. Gas Lighting Device; David J. Quinn, Brookline, and Paul W. Hoffman, Boston, Mass. Application filed Nov. 27, 1891. A gas burner and a rotatable valve therefor, a pivoted spark arm provided with ears, and a co-operating fixed contact, combined with a frame having projections to engage the ears, respectively, on alternate downward movements of the frame to oscillate the valve and arm.

478,529. Dynamo-Electric Machine; Charles W. Thomas, Jersey City, N. J. Application filed Oct. 21, 1890. An attachment for a dynamo-electric machine of shunt type, consisting of a supplemental commutator in which for each long segment there are two interposed short segments in two separate planes of rotation, all of the segments revolving with and being insulated from the armature winding and (except as to the diametrically paired short segments) from each other.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.